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Gunmetal Specifications

In July, 1930, the British Standards Institution produced their first gunmetal specifications (Nos. 382-383) covering the supply of 88:10:2 gunmetal ingots and castings. Within the past three months the first revision of these has been issued, together with two completely new specifications, Nos. 897-898 and Nos. 900-901, dealing with leaded gunmetals. It is interesting to note that the revision of the older specifications owes its initiation to joint proposals received from the Air Ministry and the Society of British Aircraft Constructors to the effect that certain of the British Standards for aircraft purposes should be cancelled, providing appropriate specifications for general engineering purposes were available. The revised issue of B.S. 383 accordingly supersedes the Aircraft Specification 2.B.2, Bronze (Gunmetal) Castings.

Non-ferrous foundrymen will appreciate the work of those who were behind this revision for at least two reasons. First, simplification of the wide variety of gunmetals used in the industry is badly needed, and secondly, the requirements formerly called for, particularly as regards chemical composition, were somewhat severe. It is particularly gratifying to observe that in this latter direction the tolerances for tin and zinc are now 0.5 per cent. either way instead of 0.25 per cent. In addition, the presence of nickel is not now looked upon as an impurity and may be present if desired up to 1.0 per cent.

The new specifications Nos. 897-898/1940 and 900-901/1940 covering leaded gunmetals of the compositions 85:5:5:5 and 87:9:3:1 respectively were authorised as a result of representations made by the Institute of British Foundrymen following the work of the Non-Ferrous Sub-Committee of the Technical Committee. In conjunction with specification 382-383/1940 previously mentioned, these additional specifications should go a long way to promote further standardisation. Necessity for constant variations in procedure to meet small points of difference in specifications for what are essentially similar materials is highly inefficient, and militates against the regular production of articles of uniformly good quality. It might be remembered that before working on these new specifications the Non-Ferrous Sub-Committee reported examining 37 private specifications, all different from one another, although the range of requirements covered is within one or other of the specifications now issued.

At the present time, full use of these new specifications will also undoubtedly assist the metal resources of the country. The production of 88:10:2 gunmetal entails appreciable consumption of virgin metal supplies, whilst production of gunmetal of the other compositions covered extends the use of secondary metal and scrap.

Desulphurisation of Cupola Iron

Elsewhere in this issue we print an interesting Paper on this subject which was given to the annual meeting of the American Foundrymen's Association by Mr. W. Levi. It is well brought out that the form and shape of the receiver in which desulphurisation by soda ash is carried out have a profound influence on the results achieved. If depth of bath be the determining factor, then it is shown that the 18-in. to 21-in. deep receivers gave a sulphur reduction of 0.045 per cent., whilst the 36-in. deep ladle increased this percentage to 0.051. To-day it is well recognised that mere sulphur reduction is not the alpha and omega of soda-ash treatment, but rather are the beneficial results consequent upon a general cleaning up of iron the predominant features.

The soda-ash process has become very popular amongst manufacturers of castings destined for incorporation in machinery of all kinds. In the light castings trade, however, progress has not been so noteworthy, as there is a general belief that during the period required for treatment the metal loses some of its fluidity. As the moulders receive their payment on good castings only, they are insistent on receiving very fluid metal. Mr. Levi's experiments, however, show that "life" was increased by 33 per cent. as measured by the A.F.A. spiral fluidity test. The worry unfortunately still remains, as the iron used only carried about 0.50 per cent. of phosphorus as against the 1.2 to 1.6 per cent. customary in United Kingdom practice.

In order better to appreciate Mr. Levi's figures, we plotted the fluidity results against the phosphorus contents listed, and a definite tendency is shown of decreasing "life" with increasing phosphorus contents. The range is restricted to 15 points, actually from 0.48 to 0.63 per cent. As desulphurising assumes increasing importance under war conditions, it does seem worth while establishing once and for all the effect of the soda-ash treatment upon the fluidity of irons entering into the higher phosphorus ranges. Even if it were shown that at the maximum phosphorus content, the effect of soda-ash was not detrimental to the running properties of the iron, then its use would still be commendable on account of its ameliorative effect in other directions.

D

Scrap Metal Problems

BY "ONLOOKER."

For months past there has been an outcry about the accumulations of low-grade scrap in this country, and prophets of gloom have suggested that if the war lasted long enough we should be faced with a veritable mountain of this type of material. Ideas of this kind while doubtless exaggerated are not so far from the truth as to make it possible to leave the situation to clear itself in the ordinary way, although the normal indications of amendment are beginning to show themselves in falling prices. When the Ministry of Supply through the Controller of Non-ferrous Metals fixed maximum prices for brass and copper scrap, the upper limits were sufficiently generous to encourage the expectation that the market in old metals could function below the ceiling arranged under the Order. Unfortunately these hopes were not fulfilled and, for the most part, those who had scrap to sell stuck out for the maximum price permitted by the official list, while certain types which were not listed climbed to unreasonable levels. This course of action was facilitated by the fact that the coming of war to Europe brought in its wake an almost insatiable demand for non-ferrous metals in connection with the manufacture of munitions, and consumers were glad enough to look round for ways and means of bolstering up their supply position.

Control Keeps Down Prices

There can be no question that many people doubted the ability of the authorities to curb the upward trend of commodity values, a belief fostered in the case of the non-ferrous metals by the advance announced in December last in this country and the strength of metal prices in New York. The Control, however, refused to be stampeded into hasty and ill-advised action, and it is a good thing that there were experienced people at the helm, for to-day the trend of the world price, in copper at any rate, is definitely downwards, and those who accumulated stocks of secondary metal in the hope that values of virgin metals would advance again have burned their fingers. That there are large stocks of certain grades of scrap on hand seems fairly certain, for in pre-war days the U.K. exported some lines to the Continent, mostly low-grade scrap, and to-day that is no longer possible. Apparently the authorities considered the situation sufficiently important to warrant official intervention, and an announcement in this connection has recently been made by the Ministry of Supply.

Briefly the scheme provides for the purchase from the smelters of rough copper and remelted pig lead, the former at £54 for material assaying 99 per cent. and better and £53 for a lower grade down to 97.25 per cent., while the price offered for pig lead returning 99.98 per cent. purity is £22 10s. Both these figures are on the basis of ex-seller's works. The value placed on secondary lead compares with £25 delivered consumers' premises for virgin, so that the margin is not very wide, but it is sufficiently generous for such a pure metal, and moreover the permitted limits of impurities in this remelted lead are decidedly onerous. Too onerous as a matter of fact in the opinion of a good many people. In the case of copper no stipulation is made beyond that of copper content, and one would expect a fairly enthusiastic response to the Ministry's offer.

Iron Railings as Scrap

Public authorities have been ordered to make a survey of all iron, publicly and privately owned, so that a comprehensive scheme to remove all unnecessary material can be made.

The Purchase Tax

The text of the Finance (No. 2) Bill, which incorporates the new supplementary Budget proposals, has now been issued, and in a schedule particulars are given of the goods that will be chargeable with the Purchase Tax. Among the articles incorporating castings that will be chargeable at the full basic rate of one-third of the wholesale value are the following:—

Fittings of a kind used for interior domestic or office lighting, the following: Brackets, pendants, candelabra and electroliers. Domestic cooking and heating appliances, and other appliances and apparatus of a kind used for domestic purposes.

Articles of hardware and ironmongery of kinds used for domestic or office purposes. Turnery of a kind used for domestic or office purposes. Lawn-mowers and garden rollers, garden furniture and garden ornaments.

Various fancy or ornamental articles of a kind suitable for personal or domestic use. Sports requisites and cycles.

Certain goods falling within the foregoing descriptions are to be chargeable with Purchase Tax at the reduced rate of one-sixth of the wholesale value, namely: Enamelled hollow-ware and other iron and steel hollow-ware of a kind used for domestic purposes.

Book Reviews

Glossary of Terms in Use in the Vitreous Enamelling Industry. By G. T. O. Martin, Ph.D. Published by the Joint Committee of the Institute of Vitreous Enamellers and the British Cast Iron Research Association, 21, St. Paul's Square, Birmingham. Price 1s. post free.

In this useful 10-page pamphlet definitions are given of 143 words and phrases currently used in the vitreous enamelling industry. The selection, though admittedly incomplete, is satisfactory. The one phrase to which exception can be taken is "Metal Grit" as this cannot be regarded as a current expression. The phrase "Steel grit" is unfortunately still used, but chilled-iron grit or shot should have been chosen for inclusion. It would have done much towards the elimination of the undesirable. A phrase or word designed to take care of the Wheelabrator and Sand Wizard types of shot-blasting machines would have been a useful inclusion.

Fire Protection and A.R.P. Year Book, 1940-41. Published by Lomax, Erskine & Company, Limited, 6, Tower Hill, London, E.C.3. Price 7s. 6d. post free.

About two-thirds of the 300 pages of this book form a directory of fire brigades and A.R.P. authorities, and in it is included all the information the most curious might desire, ranging as it does from the number of feet of hose available to the charge on the rates levied on the inhabitants. As for the balance of the book, there is a miscellaneous collection of information on the technical aspects of fire extinguishing (including hydraulics), air raid precautions, and historic fires. There is an advertising section covering the equipment and raw materials in the fire extinguishing "industry." In its own field, the book is obviously an authoritative work of reference.

First-Aid. By Halliday Sutherland, M.D. (42nd Edition). Published by E. and S. Livingstone, 16-17, Teviot Place, Edinburgh. Price 8d. post free.

The fact that this waistcoat-pocket booklet on first-aid has already been bought by 165,000 persons is an indication of its worth. The new edition gives information on the first-aid treatment of gas casualties.

Random Shots

Just to catch out the buyer the other day a friend asked him the following question:—

"If anyone were to offer you a ton of tobacco for £2,000 would you snap it up as a bargain?"

"Good Lord, no!" gasped the buyer. "What a staggering price. Why a good average price for pig-iron is only £6 10s. per ton!"

"Wait a minute; here are the mathematics of the job," replied the statistical one. "Say you go into a shop and buy an ounce of tobacco for 1s. 5½d. That's a reasonable price?"

"Well, yes, under present conditions," the other admitted.

"Now, then! Tobacco at 1s. 5½d. per ounce works out at £2,613 6s. 8d. per ton, or, in terms you will understand, roughly 402 times as expensive as the pig-iron you buy for the firm. The former you pay cheerfully, the latter you grumble about! Perhaps it is because so small a sum as 1s. 5½d. doesn't seem worth while worrying about, or maybe it is because you feel that as the greater part of it is tax you are magnificently helping to win the war; or can it simply be that you enjoy the stuff, so hang the price?"

* * *

The following extract from a report of a committee on malleable iron castings in America, quoted verbatim, seems to justify the saying that if you want to kill an idea just get a committee to sit on it! It reads:—

"This report has been submitted to letter ballot of the committee, which consists of 36 members; 00 members returned their ballots, of whom 00 have voted affirmatively and 0 negatively."

But, of course, they are to be excused, as this is the Presidential Election year over there."

* * *

The following little ditty has been sent in by one of the nation's warworkers. It is to be hoped that Mr. Bevin doesn't see it, or he will no doubt say that if that's how they spend that one-day-in-seven off duty, well, they'd just better get back again into the works. On the other hand, if it catches the eye of the Minister of Health he would say "You're working them silly, Bevin. Give 'em another day off!"

This is how it goes—

A Traitor to his Trade.

Forthright Fred the foundry foreman
And Cuthbert Cave the cunning coreman,
Both did what they didn't oughter—
Aspired to wed the boss's daughter.

But owner Owen's god was money,
He didn't regard their suits as funny.
And without ado—this traitor selled her
To Wily William the wealthy welder!

* * *

An article on popular science stated the other day that a man's body is two-thirds water.

In that case a steel melter's body must be seven-eighths beer, yet to look at any fair specimen you'd think he were nine-tenths brawn.

* * *

Young Hopeful wants to know why, if a maker of ships is a shipwright, a man engaged on aircraft production is not known as an aerowright? And why not, indeed, for would it not incorporate the name of the starter of all the trouble, Wilbur Wright himself, and thus serve as a permanent memorial?

* * *

Incidentally, August is supposed to be the Silly Season, but the only signs of it that "Marksman" has encountered this year so far was the other night when he met a policeman on a dark country lane putting out the glow worms, in deference to the Defence of the Realm Act.

"MARKSMAN."

Desulphurising Cupola Cast Iron from the Practical Operating Angle*

By W. LEVI

The purpose of this Paper is to discuss the actual practice followed in the desulphurising of cupola cast iron in the foundries of the company with which the author is connected. The castings manufactured include a complete line of plough castings such as chilled plough points or shares, chilled landsides, standards, and other parts for ploughs. In addition, cast-iron pipe ranging in size from 3 in. to over 60 in. in diameter is made by the pit cast method or in loam, deLavaud centrifugally cast pipe from 4 in. to 24 in. in diameter, practically all sizes of fittings for gas, water and steam service, and a wide variety of special castings for use in the chemical industry.

Historically, desulphurising cast iron is not a particularly new procedure. In fact, it is said that Horsley discussed the use in England of soda ash and other chemicals for this purpose as long ago as 1867. His chief interest at that time, however, was the effect of soda ash refinement upon the grain structure and density of the iron treated rather than the reduction of sulphur.

Melting Equipment

The melting equipment used for production castings consists of six cupolas all equipped with continuous front slagging spouts and either a forehearth or some type of teapot ladle used for the storage and mixing of iron and refining with fused soda ash. The cupolas referred to are as follow:—

No. of Cupolas.	I.D. Shell.In.	I.D. Lining at Melting Zone, In.	Forehearth. Type.	Forehearth. Capacity.
1	63	51	Box	1·4 tons
1	54	42	U-shaped teapot	2 tons
1	96	72	U-shaped teapot	10 tons
2	96	72	Elliptical teapot	10 tons
1	96	66	U-shaped teapot	10 tons

Due to the geographic location of the foundries in question, the use of large percentages of scrap iron in the cupola charge is of vital importance in order to maintain an iron cost which is not prohibitive. The amount of scrap iron used in the various mixtures ranges from about 83 to 100 per cent. With proper supervision and control, irons containing from 2.90 to 3.75 per cent. total carbon have been made repeatedly using the cupola mixtures mentioned.

In discussing the refining and desulphurising of cupola cast iron by means of fused soda ash, it must be borne in mind that every detail of good cupola practice must be given considerable thought and consideration as usual.

Preheating the Forehearth

The procedure followed in this plant for melting a 100 per cent. scrap charge consists in preheating the forehearth or teapot ladle with an oil torch for 1½ to 3 hrs. before the blast is turned on the cupola. This time varies according to the size of the forehearth and the type of burner used. However, in all cases it is important to have the forehearth lining at a minimum temperature of 1,315 deg. C. before iron is tapped into it. A superficial heating of the forehearth lining is often the cause of dull iron at the beginning of a heat and for this reason this step in the preparation cannot be over-estimated. Further, the burner used for preheating should not be removed until just before tapping the cupola. The purpose of this is, of course, to conserve the heat already absorbed by the brick in the forehearth lining.

Addition of Desulphuriser

After the iron in the forehearth has attained a depth sufficient to seal or cover the hole leading from the forehearth proper to the teapot spout, a predetermined amount of fused soda ash is added. This amount is governed by previous experience and also by the capacity of the forehearth, the object being to add a definite predetermined amount of fused soda ash per ton of molten iron.

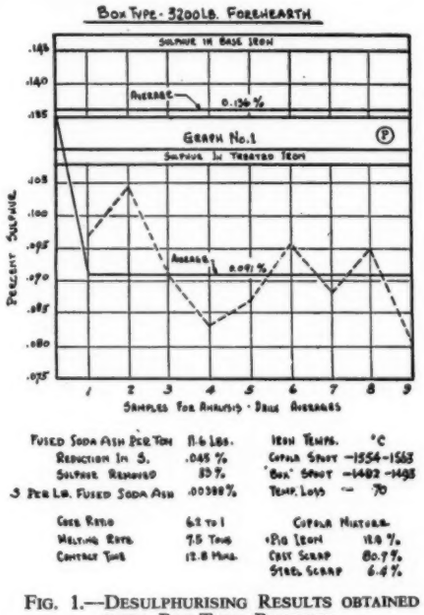
BOX TYPE - 3200 LB. FOREHEARTH
SULPHUR IN BASE IRON
AVERAGE 0.136 %
GRAPH No. 1
SULPHUR IN TREATED IRON
AVERAGE 0.091 %
PERCENT SULPHUR
SAMPLES FOR ANALYSIS - DAILY AVERAGES
FUSED SODA ASH PER TON 11.6 LBS.
REDUCTION IN S. .045 %
SULPHUR REMOVED 33 %
5 PER LB. FUSED SODA ASH .00388 %
IRON TEMPS. °C
CUPOLA SPOUT -1554-1563
BOX SPOUT -1482-1498
TEMP. LOSS — 70
COKE RATIO 6.2 TO 1
MELTING RATE 7.5 TONS
CONTACT TIME 12.8 MINS.
CUPOLA MIXTURE
PIG IRON 11.0 %
CAST SCRAP 80.7 %
STEEL SCRAP 6.4 %

FIG. 1.—DESULPHURISING RESULTS OBTAINED WITH BOX-TYPE RECEIVER.

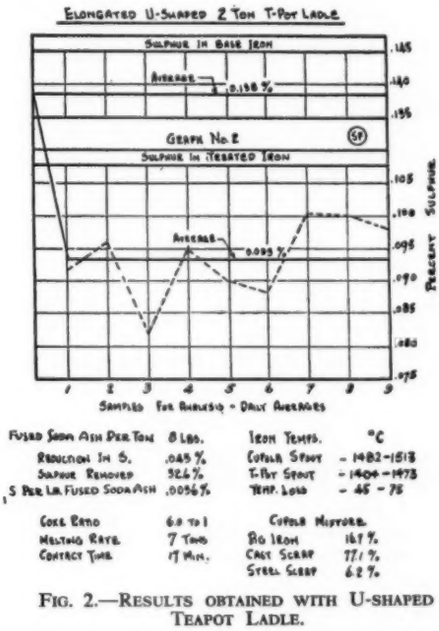
ELONGATED U-SHAPED 2 TON T-POT LADLE
SULPHUR IN BASE IRON
AVERAGE 0.138 %
GRAPH No. 2
SULPHUR IN TREATED IRON
AVERAGE 0.095 %
PERCENT SULPHUR
SAMPLES FOR ANALYSIS - DAILY AVERAGES
FUSED SODA ASH PER TON 8 LBS.
REDUCTION IN S. .043 %
SULPHUR REMOVED 32.6 %
5 PER LB. FUSED SODA ASH .0056 %
IRON TEMPS. °C
CUPOLA SPOUT - 1482-1513
T-POT SPOUT - 1404-1473
TEMP. LOSS - 45 - 75
COKE RATIO 6.0 TO 1
MELTING RATE 7 TONS
CONTACT TIME 17 MIN.
CUPOLA MIXTURE
PIG IRON 16.7 %
CAST SCRAP 77.1 %
STEEL SCRAP 6.2 %

FIG. 2.—RESULTS OBTAINED WITH U-SHAPED TEAPOT LADLE.

Before any fused soda ash is added to the molten iron, it should be dried sufficiently to drive out any absorbed moisture. This can be accomplished by placing a day's supply in a suitable oven, by placing the pieces over the cupola spout and replacing dried ones with undried ones as they are used, or by means of the flame of an oil or gas torch played on the surface of a stock pile for a few minutes prior to use.

When the forehearth is full, the iron is either tapped out or poured into a thoroughly-dried and well-preheated transfer ladle and is then taken to the pouring floor. Immediately after pouring iron into the transfer ladle, sufficient fused soda ash is added to the forehearth to treat an amount of iron equal to that which was removed. This is very important as any delay at this point reduces the time that the iron running into the forehearth is in contact with the purifying slag. When conditions are such that the ratio of the capacity of the forehearth to the cupola melting rate is small, any delay will mean that a relatively large percentage of the available contact time has been lost and consequently the efficiency of the desulphurising equipment reduced. Succeeding ladles of iron should not be taken out until the forehearth has been allowed to fill again completely. After several ladles have been taken out and a like number of additions of fused soda ash have been made to the forehearth, a layer of slag will have formed on the surface of the metal. This used slag should be skimmed off by allowing the level of the iron in the forehearth to rise to a point just below the slag spout. It has been noted that more efficient desulphurising is obtained when there is a thin layer of slag on the surface of the iron.

This cycle of adding fused soda ash to the forehearth, allowing the forehearth to become completely filled, skimming off the slag, and then pouring iron into the transfer ladle, is continued throughout the duration of the day's cast. However, it is not necessary to add soda ash for the last ladle or two as the layer of refining slag already present will continue to desulphurise for at least 10 to 15 min.

Factors influencing Desulphurisation

The amount of sulphur that will be present in a cupola-melted iron after treatment with fused soda ash is a function of a good many factors, some of which are listed below:—

(1) Type of desulphurising reservoir used.
(2) "Contact time" between desulphurising agent and molten iron. "Contact time" in minutes is defined as the ratio of the forehearth capacity to the hourly melting rate of the cupola multiplied by 60.
(3) Amount of sulphur present in the iron at the cupola spout (later referred to as "base metal") before desulphurising. This, in turn, is proportional to the amount of sulphur present in both the coke and metals charged into the cupola.
(4) Cupola melting rate.
(5) Coke ratio used for melting.
(6) Amount of desulphurising agent used per ton of molten iron.
(7) Completeness of the separation of the cupola slag from the molten iron before desulphurising.

Effect of Type Reservoir on Sulphur Removal

To demonstrate the effect on sulphur removal of two different types of desulphurising reservoirs as well as some difference in contact time, the data given in Fig. 1 and Fig. 2 are submitted. While the cupola charges and coke ratios are not identical in the two units being

* Paper read at the Chicago Convention of the American Foundrymen's Association. The author is metallurgist with the Lynchburg Foundry Company, Lynchburg, Va.

considered, the sulphur averages in the irons at the spouts are practically identical.

Case No. 1

Cupola Dimensions.—The cupola discussed in Fig. 1 is used to melt iron for chilled plough shares, chilled landside castings, standards, and other plough castings. The inside diameter of the cupola is 51 in. at the melting zone, and the average melting rate is 7.5 tons per hr. The cupola charge contains 12.9 per cent. pig-iron.

Desulphurising Reservoir.—The "box" type reservoir used in connection with this cupola is rectangular in cross-section, the dimensions inside the lining being 32 in. long, 24 in. wide, and 18 in. deep, with a capacity of 28 cwts. of molten iron. It has a brick lining 7 in. thick and the cover is lined with 4 in. of ganister. Fused soda-ash additions are made through the opening by which the spent purifying slag is skimmed off from the surface of the iron in the forehearth, that is, through the slag spout. This forehearth is of the stationary type and must be "tapped out" each time iron is taken from it.

Composition.—The analysis of the iron at the cupola spout is as follows:—T.C, 3.30 to 3.50; Si, 1.40 to 1.60; Mn, 0.40 to 0.50; S, 0.125 to 0.155; and P, 0.45 to 0.60 per cent.

Sulphur Reduction.—The average sulphur in the base metal is 0.136 per cent. and, after treatment with 11.6 lbs. of fused soda ash per ton, the sulphur is reduced to an average of 0.091 per cent. The available contact time for the refining action of the fused soda ash is 12.8 min.

Coke Analysis.—The coke used in this cupola is of the by-product type and is of the following analysis:—Fixed carbon, 92.0; sulphur, 0.60; ash, 6.0; and volatile, 0.65 per cent.

Case No. 2

For the data in Fig. 2, the cupola is used to melt iron for the production of short-length flanged pipe, socket and spigot pipe, fittings, and special castings. The maximum length of pipe made rarely exceeds 5 ft. overall and the maximum diameter of pipe and fittings manufactured is 20 in.

Cupola Dimensions.—The inside diameter of the cupola is 42 in. and the average melting rate is 7 tons per hr. The cupola charge contains 16.7 per cent. pig-iron.

Desulphurising Reservoir.—The desulphurising reservoir used is a 2-ton capacity, elongated, U-shaped, teapot-type tilting ladle. It is lined with 9 in. of firebrick, and the cover is lined with 6½ in. of ganister. The depth of molten iron in the teapot ladle when full is 21 in.

Composition.—The analysis of the iron at the cupola spout is as follows:—T.C, 3.30 to 3.50; Si, 1.65 to 1.85; Mn, 0.35 to 0.50; S, 0.125 to 0.160; and P, 0.45 to 0.60 per cent.

Sulphur Reduction.—The average sulphur in the base metal is 0.138 per cent. and after treatment with 8 lbs. of fused soda ash per ton, it is reduced to an average of 0.093 per cent. The available contact time for the refining action of the fused soda ash is 17 min.

A comparison of results shown in Figs. 1 and 2 indicates that the sulphur reduction with the "box" type of forehearth is 0.00388 per cent. per lb. of soda ash, and with the elongated U-shaped teapot ladle the sulphur reduction is 0.0056 per cent. per lb. of soda ash. This difference in sulphur reduction is due both to the type of desulphurising reservoir and to the available contact time between the soda ash and the molten iron. Sulphur reduction is proportional to contact time and, when desulphurising equipment is being installed, this phase should be carefully considered. The greater efficiency of the elongated type forehearth is due to the fact that the boiling action of the soda ash is limited to the end where the iron enters, and that the refined metal is tapped out at the opposite end. While the iron travels from one end of the ladle to the other, the soda-ash slag rises to the surface and removes sulphur and entrained impurities. By-product coke of the same analysis detailed in case I is used in this cupola.

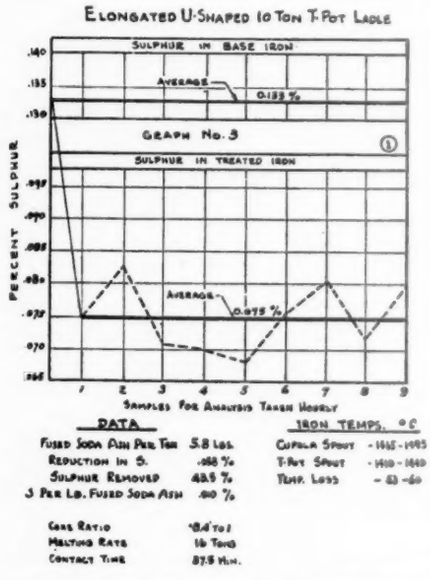

FIG. 3.—RESULTS OBTAINED ON ELONGATED U-SHAPED TEAPOT TILTING LADLE.

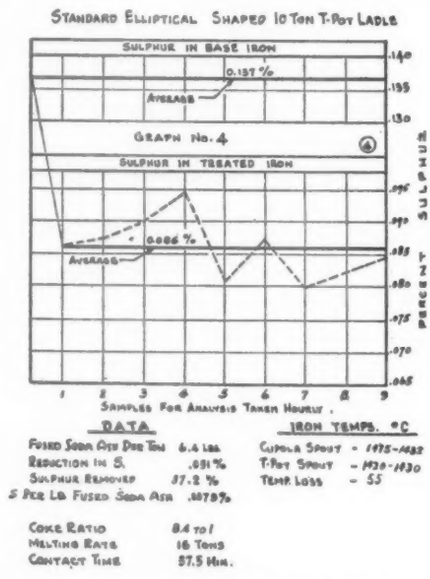

FIG. 4.—RESULTS OBTAINED ON ELLIPTICAL-SHAPED TEAPOT-TYPE TILTING LADLE.

Comparison of 10-ton Teapot Ladles

The data given in Figs. 3 and 4 are intended to point out the relative desulphurising efficiencies of two different types of 10-ton, teapot, tilting ladles. All other conditions are as near identical as possible with an operation of this size. In both cases, the iron melted is used for the production of pit-cast pipe, fittings over 20 in. in diameter, and a large variety of special shapes for use in the chemical industry.

Cupola Dimensions.—Both cupola shells under consideration are 96 in. inside diameter and are lined to 72 in. at the melting zone, and the melting rate is 16 tons per hr. The 4,000-lb. charge consists of 100 per cent. scrap as follows:—

Type of scrap.	Lbs.	Per cent.
Heavy machinery	1,200	30·0
Automobile cast	900	22·5
Returns	700	17·5
Textile	400	10·0
No. 1 machinery	800	20·0
Totals	4,000	100·0

Coke Analysis.—Coke between charges consists of 450 lbs. of beehive coke and 25 lbs. of pitch coke. The percentage analyses of the cokes used are as follow:—

	Type of coke.	
	Beehive.	Pitch.
Fixed carbon	93·5	98·0
Sulphur	0·46	0·30
Ash	5·0	0·50
Volatile	0·65	1·00

The U-shaped ladle requires 0.6 lb. less of the fused soda ash per ton than does the elliptical ladle, and at the same time removes more sulphur. The cost also varies with the type of castings being produced. Where gates and runners constitute a large percentage of the iron poured into a mould, the cost of the desulphurising material will be higher than when this percentage is small.

Case No. 3

The desulphurising reservoir used for the data in Fig. 3 is a 10-ton capacity, elongated, U-shaped, teapot type of tilting ladle. It has a firebrick lining 11½ in. thick and the cover is lined with 6½ in. of ganister. The depth of molten iron in the teapot ladle when full is 36 in. Fused soda ash additions are made to the teapot ladle at the same end that the molten iron enters and the spent slag is skimmed off at the opposite end. The refined iron is also tapped out at the end opposite that at which the molten iron enters.

Composition.—The analysis of the iron at the cupola spout is as follows:—T.C, 3.30 to 3.60; Si, 1.50 to 1.70; Mn, 0.35 to 0.45; S, 0.130 to 0.150; and P, 0.45 to 0.60 per cent.

Sulphur Reduction.—The average sulphur in the base metal is 0.133 per cent., and after treatment with 5.8 lbs. of fused soda ash per ton, the sulphur is reduced to an average of 0.075 per cent. The available contact time for the refining action of the fused soda ash is 37½ min.

Case No. 4

The only difference in conditions relative to data covered by Fig. 3 and Fig. 4 is the type of desulphurising reservoir used. Here a 10-ton capacity, elliptical-shaped, teapot type of tilting ladle is used. It has a 7½-in. firebrick lining and no cover is used. The depth of molten iron in the teapot ladle when full is about 27 in. Fused soda ash additions are made at or near the centre of the teapot ladle. This is close to the slag spout and also quite close to the point at which molten iron is removed from the ladle.

Sulphur Removal.—The average sulphur in the base metal is 0.137 per cent. and, after treatment with 6.4 lbs. of fused soda ash per ton, the sulphur is reduced to 0.086 per cent. The available contact time for the refining action of the fused soda ash is 37½ min.

The sulphur reduction, when using the elongated type teapot ladle, is 0.010 per cent. per lb. of fused soda ash and, when using the elliptical type ladle, the reduction is only 0.0079 per cent. This difference is accounted for solely by the difference in types of desulphurising reservoirs used.

Effect of Coke Ratio on Sulphur Content

The purpose of Figs. 5 and 6 is to point out the effect of coke ratio on the sulphur content

of the iron at the cupola spout, and, in turn, its effect on the amount of desulphurising material used. In both cases, desulphurising is done in the same 10-ton, elongated, U-shaped, teapot ladle that was discussed under Fig. 3. Fig. 5 is the same as Fig. 3 and naturally all data pertaining to Fig. 3 applies to Fig. 5.

To obtain the data presented in Fig. 6, the coke ratio was changed to 11 to 1 as compared to a coke ratio of 8.4 to 1 in Fig. 5. This is the only variable introduced deliberately. However, this has resulted in increasing the melting rate from 16 tons to 20 tons per hr., and this in turn has reduced the time of contact between the molten iron and the fused soda ash slag from 37.5 min. to 30 min. It has also reduced the average sulphur in the iron on the cupola spout (base metal) from 0.133 to 0.123 per cent.

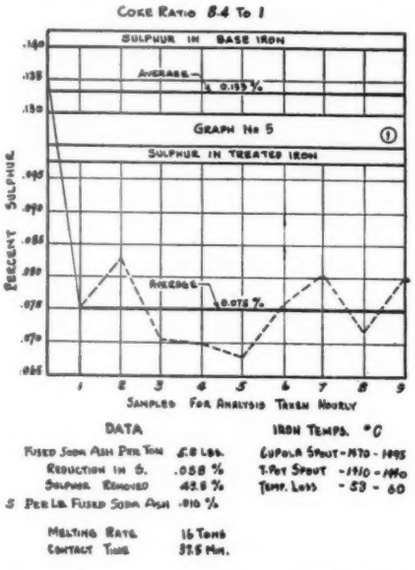

FIG. 5.—SULPHUR CONTENT WITH COKE RATIO OF 8.4 TO 1.

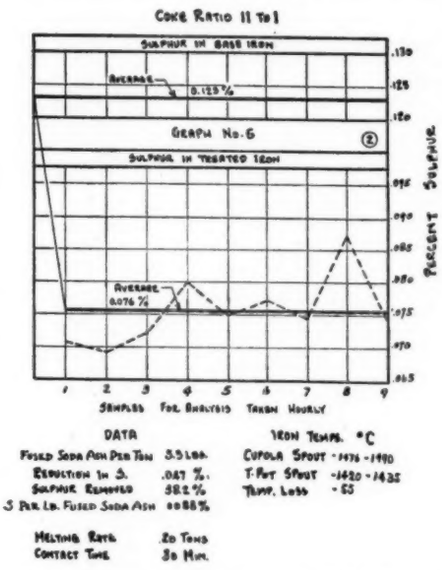

FIG. 6.—SULPHUR CONTENT WITH COKE RATIO OF 11 TO 1.

TABLE I.—*Influence of Soda Ash Additions on the Fluidity of Cupola Melted Iron.*

Test No.*	Base iron.						Desulphurised iron.					
	T.C.	Si.	Mn.	S.	P.	Fluidity. Ins.	T.C.	Si.	Mn.	S.	P.	Fluidity. Ins.
1	3·57	1·62	0·32	0·137	0·48	26	3·52	1·53	0·38	0·086	0·63	36
2	3·46	1·57	0·48	0·135	0·62	25	3·51	1·59	0·41	0·087	0·57	34
3	3·40	1·58	0·51	0·133	0·69	26	3·49	1·52	0·38	0·090	0·60	32
4	3·60	1·44	0·41	0·145	0·49	24	3·47	1·54	0·36	0·094	0·53	35
5	3·64	1·61	0·47	0·141	0·40	28	3·50	1·56	0·38	0·081	0·57	38
6	3·49	1·59	0·34	0·137	0·60	29	3·55	1·66	0·40	0·087	0·52	37
7	3·66	1·63	0·39	0·132	0·46	27	3·50	1·58	0·38	0·080	0·50	40
8	3·44	1·72	0·37	0·145	0·48	30	3·52	1·57	0·40	0·082	0·52	38
9	3·58	1·67	0·40	0·130	0·51	31	3·54	1·55	0·40	0·084	0·48	38
Av.	3·54	1·60	0·41	0·137	0·52	27·3	3·51	1·56	0·39	0·086	0·54	36·4

* The test numbers do not relate to the corresponding samples in the two irons.

Examination of the data presented in Fig. 5 shows the sulphur reduction per lb. of fused soda ash to be 0.010 per cent. Fig. 6 shows the sulphur in the base metal to be 0.010 per cent. lower than the base metal sulphur in Fig. 5, and on this basis one might assume that, to arrive at the same sulphur content in the desulphurised iron, it would be satisfactory to use 1 lb. less of fused soda ash per ton under the conditions described in Fig. 6 than under those described in Fig. 5. However, from actual practice it was found that to arrive at the same sulphur content in both treated irons, it was possible to make a reduction in the amount of fused soda ash used of only ½ lb. per ton. The actual reduction is from 5.8 to 5.3 lbs. This is accounted for by the reduction in contact time resulting from the increased melting rate.

Desulphurising and Fluidity

The effect of desulphurising cupola cast iron on its fluidity is a subject of considerable controversy, and it is the belief of some that the sulphur reduction in no way affects this property. It does appear, however, that the removal of entrained silicates and cupola slag coming out of the cupola with the molten iron does increase the fluidity. Removal of these undesirable materials from the molten iron takes place simultaneously with desulphurising, and it is stated that it requires about 1 lb. of fused soda ash per ton of molten iron to accomplish this.

In making fluidity tests, the standard A.F.A. fluidity test pattern was used. All moulds were rammed from the same sand heap which had a permeability of 38, a green shear strength of 1.2 lbs. and a moisture content of 6.9 per cent. A sample of desulphurised iron was caught in a 50-lb. hand ladle and poured into one of the moulds at a temperature of 1,315 deg. C. Next a sample of iron was caught from the cupola spout and poured at 1,315 deg. into a second fluidity test mould. It is obvious, from the procedure just described, that the sulphur content of the base metal will be higher than that of the desulphurised iron. In addition, the individual determinations of silicon, manganese, phosphorus, and total carbon made on the base iron are not identical with those made on the corresponding sample of treated iron. However, the average analyses of the base iron and the desulphurised iron are, with the exception of sulphur content, very nearly alike.

Data covering fluidity tests on cupola cast iron

(*Continued at foot of third column.*)

The New Truck Act

The Truck Act, 1940, is consequent upon a recent law case (Pratt *v.* Cook), and to understand the reason for this it is necessary to recall certain provisions of the Truck Acts, 1831 to 1896. These statutes, which apply to occupations of manual labour, provide that wages must not be paid (or partly paid) in goods or otherwise than in current coin (the term includes notes) of the realm. There are, however, certain exceptions where deductions for goods and services may be made, but only if the employee has agreed in writing to such deductions. These exceptions include medicine, fuel, rent of a house, education for workers' children, and the provision of meals on the employer's premises (*e.g.*, canteen). It is the last item with which the recent case was concerned, but the new Act necessarily covers all the matters just mentioned. The legal position which the court's judgment shows is best understood by examples. If an agreement is made for 53s. cash weekly wages, with meals to the value of 10s. to be provided, that is illegal; if the agreement calls for 63s. weekly wages, with a deduction of 10s. to be made for meals provided, that is legal, but only providing that the employee agrees in writing to the deductions.

The plaintiff in the case mentioned obtained £397 10s. for wages paid in kind (*e.g.*, meals), although these meals had been consumed, really on a misconstruction of the law of the Truck Acts, and this new Act has been passed as there have been many agreements based on a similar mistaken construction of the law under the Truck Acts; note the first example just quoted above.

Section 4 of the 1831 Act gives power to the employee to recover any amount paid in kind, even though the things concerned have been received; Section 9 lays down the penalties upon employers for paying wages in kind, and Section 23 gives the exceptions where allowable deductions apply, with the requirement concerning the written consent of the worker to such deductions.

This new Act now provides that any action (under Section 4) as regards anything done before July 10 (the date of the new Act) under Section 23 which might have been lawfully done, if the employee had agreed to the deduction in writing, shall not be instituted, and as regards any action already instituted (before July 10) this shall be discharged and made void, and this applies in respect of Section 9 also. The court is given power either to award or withhold costs to the plaintiff in any action in the last-named category, and this discretion is expected to be used favourably for the plaintiff where the action was entered before April 18, when the Government stated that this new Act was contemplated, and costs will be probably refused if an action was entered after that date, notwithstanding that this statement was known.

(*Continued from previous column.*)

are set out in Table I. These data were taken at the same time some of the data shown in Fig. 4 were obtained, and consequently the same conditions apply in both cases. The sulphur reduction obtained was from an average of 0.137 per cent. to an average of 0.086 per cent. with the use of 6.4 lbs. of fused soda ash per ton of molten iron. The increase in fluidity was from 27.3 in. (average) to 36.4 in. (average) in the desulphurised iron. This means an average increase in length of the fluidity test strip of 9.1 in. or 33.3 per cent.

It is not to be understood that to obtain an increase in fluidity of 33.3 per cent. requires the use of 6.4 lbs. of fused soda ash per ton of metal, as increases of the same order of magnitude have been obtained with the use of 4 lbs. per ton.

The Electric Furnace in the Steel Foundry

By FREDERICK A. MELMOTH (Detroit Steel Casting Company, Detroit, Mich.)

Paper presented to the 77th general meeting of the [American] Electrochemical Society.

Between 250 and 300 foundries in the United States of America are engaged in the production of steel castings, and of these approximately 200 make use of electric melting processes for the whole or part of their production. This figure indicates that the electric melting of steel for castings has assumed very important proportions, and it is significant that the figure tends to increase.

The most important factor in the difficult production of satisfactory steel castings is close control of operating conditions. The introduction of control methods to electric steel is reducing rapidly the somewhat hit-and-miss methods of a decade or two ago. To-day, combining art and science, foundrymen can predetermine conditions requisite for producing electric steel of desired composition, and they can control and regulate these conditions.

Specifications are to-day applicable to all phases of production, including moulding sand, binders, methods of pouring and feeding, heat-treatment, etc. In no case are such specifications more vitally important than in the preparation of steel of suitable qualities. Due to the success of the entire cycle the electric furnace has gained a firm place in the confidence of steel founders. The ability to control operations and the wide range for handling various classes of material are outstanding features of the electric furnace process.

Metallurgical Considerations

Electrically, the furnaces used are almost all of the alternating current, 3-phase type, with automatic control of the electrodes. Metallurgically, the furnaces fall into two types, acid and basic, depending upon the lining used. In the acid type the lining is of a highly siliceous material, usually silica brick, and the actual hearth either silica sand or ganister. This hearth is either rammed or sintered into position, usually the former.

Acid-lined furnaces, operating as they do with an acid slag, are incapable of bringing about any refining effect as to sulphur and phosphorus. As these two elements are, except under special circumstances, deleterious impurities in steel, it follows that acid practice necessitates the careful selection of melting stock in order to keep the sulphur and phosphorus contents sufficiently low to avoid trouble. Most specifications for engineering steel castings include definite upper limits for these two elements, rarely exceeding 0.05 to 0.06 per cent. sulphur or phosphorus, which emphasises the importance of careful stock selection for acid electric melting. In spite of this shortcoming, the other advantages of the acid production method have so impressed themselves upon the steel founders that for plain carbon and low alloy steels almost all furnaces in this country are acid-lined.

Werner Finster, at a symposium on steel melting practice, held under the auspices of the American Foundrymen's Association in 1939, lists the advantages of acid linings as follow:—

(1) Lower refractory cost, due to lower cost of the lining material itself and to a longer life of the lining material.

(2) Lower power consumption, especially when compared with the two slag basic processes.

(3) Greater tonnage output per unit time for a given charge.

(4) Slag of higher viscosity, which is an important consideration, as in many foundries making small castings the mould has to be poured from hand shanks.

(5) Greater fluidity of the metal, permitting the casting of thinner sections with greater assurance of having all corners and details clearly reproduced.

Most operators, with experience in both acid and basic practice, will be in practical agreement with the claims made. However, the use of a basic lining confers certain distinct advantages from a purely metallurgical viewpoint, and renders the electric furnace the most flexible metallurgical melting unit available, and probably the most easily controllable. Under basic conditions, when melting straight carbon steels, sulphur and phosphorus can be reduced to almost negligible proportions, making careful selection of the scrap material fed to the furnace unnecessary. However, when melting scrap containing oxidisable alloys which, as desired, shall figure in the final analysis, it is quite obvious that high-phosphorus scrap is not applicable. In this case, with a basic lining it is necessary that the phosphorus content of the scrap material be at a predetermined very low figure.

With the basic-lined furnace, when alloy additions are made the constituents are found present in the finished steel in almost exact, calculated quantities, the losses in slag being practically non-existent. Control of analysis, therefore, is remarkably simple. For special alloy compositions the basic-lined electric furnace with its reducing atmosphere is unequalled.

Under these circumstances, the development and popularity of acid-lined furnaces in the steel foundry may appear strange, but it has to be borne in mind that the production of a steel casting is a composite of a large number of operations, and of variation of type. Steel manufacture, as such, merely represents one phase of such production, and unless it is able to meet the practical foundry demands made upon it, any process, no matter how metallurgically accurate and controllable, is unlikely to succeed. Economy of operation is a powerful factor in favour of the acid lining. Furthermore, in the opinion of most practical operators, the acid-lined electric furnace produces a material easier to pour into thin sections and possessing that vague quality described as "life." It is hard to imagine a greater handicap in a steel foundry than a molten steel difficult to pour into thin sections, owing either to sluggishness or inability to retain for a practical period sufficient fluidity to pour the necessary number of castings completely.

Physical Properties

As to physical properties of the steel, the electric furnace, whether acid- or basic-lined, is capable of producing metal which will meet any existing specifications, usually with a reasonably safe margin. Here, in the author's opinion, basic linings represent the maximum of simplicity, the steel being unusually responsive to heat-treatment and possessing the highest possible combination of strength and ductility. In this respect the acid process has presented difficulties.

Steel for use in castings is subjected to conditions in pouring very different from those existing in the production of ingots. In the latter case, the liquid metal is poured into substantial metal moulds, clean and free from moisture, and is therefore exposed to the minimum of unsettling effects. However, almost all light and medium-sized steel castings are poured into green-sand moulds containing as an essential part of their composition some 3 per cent. of water. In light castings, having a very high proportion of surface area to total mass, the hot liquid steel comes in contact with water vapour and other gases which give rise to blowholes during solidification of the metal. Therefore, to overcome these blowholes, it has become common practice to use final deoxidisers, such as aluminium, titanium or zirconium, sometimes in combination, in order to ensure soundness.

It was found very early in the development of electric cast steel that such deoxidation was followed by a considerable decrease in ductility of the finished steel. In earlier days this was attributed to alumina formed as a result of oxidation of the added aluminium, but the work of Sims and Lillieqvist threw new light on this problem. The change in type of certain almost unavoidable non-metallic inclusions by the direct action of the added aluminium, the new type being of such shape and location as to influence ductility, has now been pretty well accepted generally as the real explanation for the decrease in ductility. It is interesting to record that the cure suggested by these investigators, and now being confirmed in many steel foundries, was a substantial increase in the aluminium addition, which under definite melting conditions results in a return almost to normal ductility properties.

Economic Considerations

Viewed technically, it can be stressed that the electric steel melting process is firmly established as part of modern steel casting production, and that technique of production is so developed that every reliance can be placed upon the resulting material. Flexibility both in size of furnace and type of material produced, low melting losses and the almost perfect control of composition, have probably been the most effective causes for this development.

The continuance and extension of the use of the electric furnace process as it applies to foundries are dependent upon two main factors: (1) the limitations imposed by refractories and the possibility of improvement in this direction; and (2) the cost of electric power and furnace installation. Within reasonable limits, the full utilisation of the heat made available by the electric arc depends upon the ability of the lining refractories to withstand it.

Economically, electric melting of steel is more expensive owing to the fact that at the present cost of electric power the production of the necessary temperatures electrically is out of line with the cost of using fuels. However, the undoubted advantages of the electric process for special alloys and applications ensure it a place in spite of higher costs. A more rapid growth of the electric process in foundries is hampered owing to the highly competitive nature of the product produced in foundries, and the consequent necessity for rigid cost regulation. In this connection it is interesting and of value to consider the rise into popularity of a steel-making process, and the factors contributing to the ultimate decline in its use. The Bessemer converter, with the development of the principle by Robert and Tropenas, offers a definite case in point.

The principle fundamental to this type of melting furnace is the production of the necessary temperature in a bath of molten iron, by the combustion of a large part of its own oxidisable constituents. By the passage through the molten iron as in the Bessemer, or by impingement on its surface as in the Robert or Tropenas modification, oxygen in the form of air combines with manganese, silicon and carbon existing in the iron, producing oxides of these materials, and simultaneously the necessary temperature to ensure a practical degree of fluidity in the finished steel. Final additions of deoxidising alloys, etc., are made to produce the desired analysis and assure soundness.

(*Continued on page* 108.)

Stack Moulding as an Aid to Production

By WM. Y. BUCHANAN

Adaptability has always been one of the most valuable assets of the foundry. This quality was most commonly exploited in the so-called jobbing foundry, but in the new era of machine moulding and specialised production, the foundry operations have become more mechanical all round, requiring the use of specially suitable moulding machines and jig-bored boxes. This being so, the tendency in the case of sudden emergencies is for production to be held up awaiting the manufacture of boxes.

In the present sudden expansion of foundry business due to war conditions, this problem of plant becomes important, and it is here that the factor of adaptability allows the foundry to rise to the occasion by makeshift means.

The sudden expansion in the demand for small castings up to about 30 in. maximum overall dimensions and under ¼ cwt. urgently brought up the question of floor-space conservation, due to the vast quantities of castings entering this category which are required by the machine-tool and general engineering trades. This applies more particularly at the present time, since working hours have been greatly increased in an already busy industry.

The question of floor space cannot readily be solved by merely adding new bays to one's foundry at short notice, and the work of most foundries is not suited to the conveyor casting system. The only other remedy is to increase the output per unit of floor space, and this brings up the method of building one mould above the other, commonly known as stack moulding.

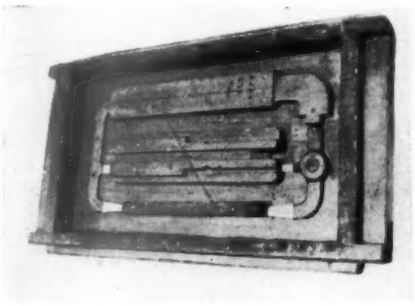

Fig. 1.—Pattern showing Gating Arrangements for Three Castings. The Block Dimensions are 36 in. by 20 in. by 3¼ in.

This is usually carried out in green sand using one drag box, a number of mid parts, and, finally, one top part. The moulds may require expensive pattern-plates, single or double sided, and the use of a hand jolt and strip or power jolt, squeeze and pattern-draw machine.

The single-sided plate is fairly simple, as the mid part has a flat top, but the process is complicated considerably when an impression of the pattern is required on both sides of the mid part. From this it is obvious that green-sand stack moulding cannot be adopted at short notice and is unsuitable for small numbers off a great variety of patterns. In machine-tool production thousands of patterns may be in circulation, coming to the foundry at very short notice for quantities ranging from 1 to 48.

Limitations of Green-Sand Practice

The number of boxes which can be used in a green-sand stack is limited by the pressure which the lowest box will withstand, and in the case of machine boxes without bars this safe limit of height is not much over 24 in., even with careful ramming of the drag and hand tucking after setting it down on the floor. Indeed, the process in green sand seems only suitable for castings of the piston-ring type in which the metal will set quickly and terminate the interval of effective pressure of the liquid metal.

For castings over an inch in thickness the metal remains liquid for quite an appreciable time, and, under the steady pressure, the time factor allows heavy swelling to occur due to the sand flowing under pressure. This, of course, can be remedied to a large extent by drying the moulds, but the only advantage of green sand, that of immediate turnover, is thereby lost and it seems that this is never done in the industry.

The ratios of strengths of green sand, dry sand and oil sand may be taken roughly as 5, 100 and 500 lbs. respectively, and the limit of height of stacking will be controlled by these relative strengths.

Fig. 2.—Stack of Castings 13 High, after removing the Sand. It is a Good Example of Floor Space and Mould Material Conservation.

It is, however, not convenient or necessary to make stacks of an overall height greater than say 7 ft., even when starting the stack in a pit, and climbing on top of a barrel in order to pour a stack is inclined to make one ponder over the slogan "Safety First." Again, the maximum height of stack may be regulated by the thickness of the casting and the minimum thickness of sand between the castings, because the metal may remain liquid long enough to destroy the organic bond material and cause partial or complete collapse of the sand under liquid pressure.

Oil-Sand Stacks

In oil sand, the stack is built of a series of blocks secured by ramming up in any suitable mid-part boxes or frames and the blocks are made in an ordinary wooden core box into which the patterns are fixed. The wooden open-topped "core" box is made in the usual style, of a depth, for example, 2½ to 3 in. for patterns about 1 in. thick, leaving a minimum depth of sand of 1 in. to cover the pattern, *i.e.*, between each casting in the completed stack.

These patterns are placed in the most suitable arrangement and preferably fixed. The gates are also best fixed by the patternmaker, and once a number of these gate patterns have been made they can usually be worked in to suit all sorts of castings of roughly similar size. An example of this method of gating is shown in Fig. 1 as applied to three patterns, namely, a taper motion-bar, a special lathe slide, and a saddle wedge. All these castings are machined all over and are required free from surface defects. Simple castings only are illustrated in the examples given, but it is just as easy to make oil-sand "cores" or blocks into which smaller cores are placed and secured by a cement of a semi-solid core oil. Stack moulding is certainly not confined to simple block patterns.

Cast-iron grids are of course not used in these oil-sand cores or cakes, but pieces of round iron, used very sparingly, give additional safety in handling. These are recovered from the stack and are available for use for an indefinite period. It does not seem to be necessary to coat these rods with claywash or core-oil solution in order to get the sand to adhere. The rods or wire can of course be bent to fit between the patterns as required and some form of bending machine may be provided to facilitate this work if quantity warrants its installation. If this is not provided the moulders will usually be found bending the rods by placing one end through a hole in the bench or part of the moulding machine with indifferent results and possibly some damage to bench or machine.

The ramming can be as hard as possible without causing mould defects due to the low permeability of the mixture. Moreover, it is best to do so in order to keep down any tendency to "searching" or roughness on the casting surface. This precaution is necessary when using burnt or ground rebonded core sand.

Fig. 3.—Half-Pattern for Vee-Belt Pulley.

Gating for Grouped Castings

While the position and arrangement of gates in foundry practice usually follow certain more or less unwritten laws established by long experience, the question of arranging the patterns in the box so as to make the best use of the available space must also be considered, and the arrangement adopted may mean running the metal through one casting to another and in this respect considerable latitude may be taken. An example of gating is shown in Fig. 2 in which four small saddle wedges are run between two larger castings.

Other types of casting, such as the Vee-belt pulley (Fig. 3) which tends, owing to its shape, to solidify with a porous patch or cavity in the bore of the boss, may be stacked with a riser continued from the boss of one casting through each in turn to the top, so that one rod may feed the entire stack of castings with very good results. The same method applies to such castings as shaft couplings. After ramming and stripping the oil-sand core or block, a groove may be cut in opposite sides which

makes for ease of lifting the core into the correct position on the stack. This is illustrated in Fig. 4.

The blocks or cores may be swab-painted but preferably sprayed with blackwash or core-oil solution or quite a variety of liquids such as core-oil solution with blackwash or plumbago in suspension. Silica-flour washes have been suggested but there is a strong tendency for this type of wash to cause small scabs all over the metal surface, and it is difficult to see how it can be any better than the carbonaceous coatings. Here it should be noted that the writer is merely expressing his own experience in the matter.

The drying, it may be argued, introduces an operation which is not required in green sand; moreover, stove capacity is required. The writer found it of distinct convenience to install a small stove in a shed off the foundry proper where the cores or blocks are dried and only taken into the foundry in complete lots immediately prior to stacking. The drying stove should be controlled by a pyrometer, and this must not be neglected even though the stove is relatively small and the pyrometer expensive.

Assembly

The assembly of the stack is carried out by first placing a drag box with flat bars level and partly filling and levelling with green sand. The lowest or bottom "core" or block has, of course, no down gate, and each successive block is registered merely by placing the sides in line. No pins are necessary, but a short piece of round wood may be used to make sure that the down gates are strictly in line. It is usual to rub over the inside of the mould surface with a piece of emery paper, as this smoothes off any small pieces of sand which may have been brushed into relief by the blackwashing process.

The mid parts or frames are then placed in position and rammed up with floor sand. Any discarded machine boxes will serve for this purpose if the bars are broken out. It is beneficial to separate the mid parts with small pieces of scrap in order to allow the free passage of gases during casting.

The top box should be a few inches above the cake or top core and bars laid across the box, a large weight put on the bars and the core wedged down by driving wedges between the top core and the bars supporting the weight. The runner basin may then be made-up ready for casting.

Advantages of Process

The "core box" can be made in an hour or so, and if two or three of different sizes are made, the patterns can be frequently changed; so long as the runner is left in one position, these can be stacked indiscriminately. If this "core box" is mounted on a jolt rollover machine, a very rapid production can be obtained, and, after drying, these can be stoved or handled with ease.

The oil-sand cores or blocks can, however, be just as readily made by hand or on a plain jolter and roughly handled; for example, in turning over, it is not necessary to put the core plate on the box, to clamp it securely, and then to turn them over together. All that is required is to place the core plate on a bench, stand the core box on edge in the correct position, and to drop it over smartly on the plate, then lift off the box, as the core or cake will loosen usually with the force of the impact.

Where an assortment of castings with various numbers required is available, the moulder can remove these or work them loosely, so long as the position of the down gate remains fixed for registration purposes.

For double-sided work it is simply necessary to use two half-patterns, or one only if the halves are exactly the same as is the case in Fig. 3, but the gate pin must be switched over to a symmetrical position for the other halves. The depth of sand may be cut down to a minimum—for example, 1½ in. of sand between castings 1½ in. thick. By this means a large number of castings of the type shown in Fig. 2 have been cast in a stack. One example was five or six castings per block 21 high, *i.e.*, 5 ft. 3 in., giving a total of 105 castings per stack, all on a floor space 3 ft. by 30 in.

With bulky castings, which means in this case where the thickness is over 4 in., and the diameter 10 in., the sand between each casting should not be so limited that the oil-sand becomes burned out while the metal is still liquid. In such conditions the lower casting will be lost due to excessive swelling or running together. This will happen when the thickness of sand is reduced to the region of 1 in. It is, however, worth sacrificing a stack or two to get this experience in order to take full advantage of the great strength of this moulding material.

Many castings such as wedges, slides and taper motion bars are required in large numbers of types, with small numbers off each, to be machined all over as these when cast flat are difficult to get entirely free from small specks

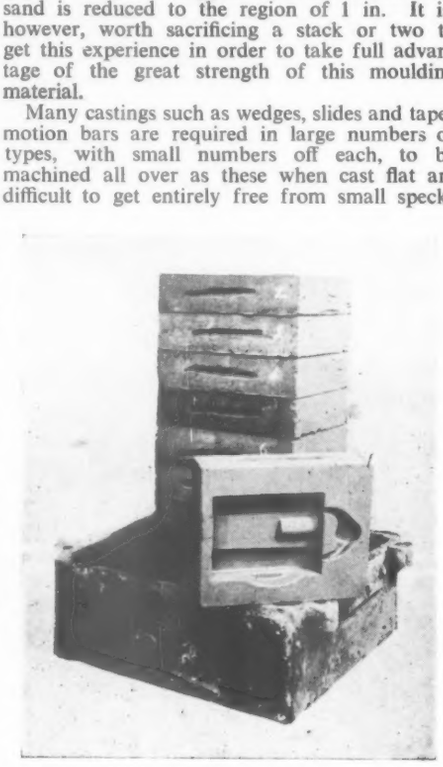

Fig. 4.—Stack of Blocks ready for Ramming Up. Note the Grooves cut for Aiding Handling.

of sand in the machined surface. The use of good oil sand eliminates this, largely due to the stronger edges and corners in the ingates, etc., which resist "washing." The use of pressure of head of metal found in stack moulding in oil sand is very beneficial when freedom from porosity is essential in difficult sections, and this has been successfully applied to pressure-tested jobs without the use of risers, chills, etc.

The increased production per unit of floor needs no stressing. Twenty-one boxes, 30 in. square, would require a large area because it is not only the row but the casting clearance between the rows which must be considered. The close packing of castings gives a very decided annealing effect which facilitates machining, and for this reason a hard close-grained metal may be used without any danger of white edges or fins.

Recovery of Oil Sand

The economical use or re-use of moulding sands has always proved a useful study, and green sand and dry sand can be very efficiently handled by the now orthodox composite cleaning, milling and aerating plants. The recovery of oil sand is also practised in a more or less standard manner by crushing and roasting, and this system is desirable and economical in large mechanised plants. In many foundries when complete mechanisation is impossible, the normal turnover of oil sand may be insufficient to warrant the installation of reclaiming plant of the usual type on the strength of the present war turnover, which is likely to fall off again after the war.

The recovery of oil sand without the proper composite crushing and roasting plant is not a simple matter, and one is constantly exercised mentally to decide when it is economical and when it is not. Even when there is not much margin of profit in the recovery, it is more or less a duty to carry this process as far as possible to obviate unnecessary rail transport of new sand to the works and cartage transport of discarded sand out of the works under present conditions.

The separation of oil-sand cores from the average dry-sand mould is only possible so long as the oil-sand core is only burnt on the surface and the remainder of the core can be lifted in one piece for ease of collection with the separation of sand contaminated with the clay-bonded sand.

In casting these stacks it will be found that the oil sand is finally reduced to powder and may be recovered for remixing after sieving through ¼-in. mesh only. This recovered material may be used 100 per cent. with satisfactory results so long as firm ramming is used. Such quantities could not be used, of course, indefinitely owing to loss, but any other percentage such as 50 per cent. old and 50 per cent. new sand may be used at will. The technique of mixing and the percentage of core oils used are exactly the same for this recovered sand as for new sand.

The Electric Furnace in the Steel Foundry

(*Continued from page* 106.)

The process is rapid, more so than any other, and in good hands the steel is of first-rate quality for general steel castings. It is probably the easiest steel to pour of any, owing to a fluidity inherent to the process, and it behaves well under the conditions forced upon it by green-sand moulds.

Yet this process has largely disappeared from [American] steel foundries, in spite of its many decided advantages. The major reasons for its disappearance are well known, and the instance is quoted only as a confirmation of the author's opinion that in these days of research and discovery any process which possesses features entailing undue cost is likely to be superseded at very short notice. High melting losses (from 13 to 17 per cent.) and the wide spread between steel-scrap and pig-iron prices, coupled to a probably exaggerated significance attributed to sulphur and phosphorus, caused the downfall of the converter process.

High cost of electric power in some localities, the cost of electrodes, and a high original cost of installation, present a standing temptation to the ingenuity of process inventors. Good as it undoubtedly is, unless operating and installation costs are further reduced, the electric furnace process is liable to attack by new methods and processes. The electric furnace industry has provided the steel foundry with a splendid tool, but it cannot afford to rest on its well-earned laurels.

The hard facts of industrial economy, and possible changes in relative values of scrap and of pig-iron, desulphurisation processes, cheap and easy to perform, constitute a combined challenge to the electric furnace as an economic piece of foundry apparatus, which challenge can only be met by a modern progressive attitude of improved economy and efficiency on the part of its proponents.

Decomposition of Pearlite in Grey Cast Iron*

By A. A. TIMMINS, A.I.C. (British Cast Iron Research Association, Birmingham)

It has been known for some considerable time that grey cast iron undergoes a change in its structure on heating at high temperatures and that this change is due to the breakdown of the combined carbon. The phenomenon of "growth" has done much to promote the study of the conditions governing this decomposition. With the advent of the heat-treatment of cast iron, an exact knowledge of the mechanism of pearlite decomposition has become more desirable.

However, the most extensive work in this direction has arisen in the study of malleablisation processes in the production of malleable cast iron. Much pioneer work has been conducted on the breakdown of free cementite in malleable cast iron by Schwartz[1] and his collaborators. He and also White and Schneidewind[2] have put forward the suggestion that malleablisation is brought about by the formation of nuclei in the iron which act as centres for the precipitation of temper carbon.

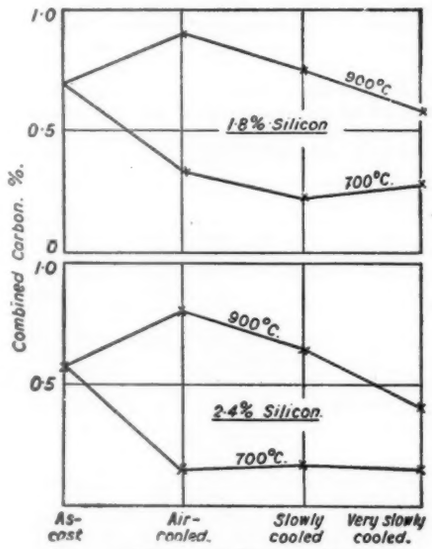

FIG. 1.—EFFECT OF RATE OF COOLING AFTER ANNEALING.

When these nuclei are formed, these workers suggest, the carbon in solution in the austenite migrates towards them, and is deposited there as free carbon. This migration continues until the equilibrium carbon content for that particular heating temperature is reached.

This idea is supported by the fact that curves relating to the graphitisation rate of free cementite are similar to those of well-known diffusion phenomena. Ishiwara[3] has also shown that the diffusion velocity of carbon in iron is a logarithmic function of the temperature and follows a curve similar to that of the relationship between the graphitisation rate and temperature. Kikuta[4] has demonstrated that the rate of breakdown of cementite in white iron is increased with an increase in the silicon and carbon content.

Thus, so far as malleable cast iron is concerned, malleablisation depends on: (1) The mobility of carbon in austenite, and (2) the tendency to form nuclei. The variability of this latter point often obscures the true nature of the changes. Thus, fine-grained white irons are found to malleablise more easily than coarse-grained irons of the same analysis.

Kikuta and, later, White and Schneidewind have also shown that the removal of pearlite by heating at temperatures below the critical point (second-stage graphitisation of malleable cast iron) may also be explained by the same reasoning, the latter authors suggesting that the carbon goes into unstable solution in α-iron and then migrates to the graphite nuclei, where it is deposited.

So far as grey iron is concerned, it is probable that no nuclei are formed, these being provided by the large number of graphite flakes already present.

Whilst a study of graphitisation rates is probably more important from the point of view of malleable cast iron, it is also of great interest to the grey-iron industry. With the advent of modern mass-production methods, resort must be had to annealing in order to obtain the high machining speeds required. Whilst it is known that cast iron can be softened by annealing, the exact procedure to be adopted is not often understood. The question of annealing is also of importance from the point of view of stress removal. This is a treatment sometimes carried out at temperatures near the critical point and has for its object the removal of stresses imposed during the cooling of the casting in the mould. As the pearlite is the main factor so far as strength is concerned, it is obviously important to use a temperature which will not destroy the pearlite and so weaken the casting.

Experimental Data

An investigation was conducted with a view to determining the conditions governing the decomposition of pearlite in grey cast iron. For this purpose two irons of similar composition except for the silicon content were obtained in the form of 1.2 in. dia. bars. The percentage analyses of the bars were as follow:—

	Iron *A*.	Iron *B*.
T.C	2.96	3.09
C.C	0.70	0.56
Gr	2.26	2.53
Si	1.85	2.42
Mn	0.56	0.73
S	0.03	0.03
P	0.18	0.23
Cr	0.12	0.13

Sections of ½-in. thickness were cut from the bars and heated in a small electrically-heated tube furnace. The temperatures chosen were 700 and 900 deg. C., so that the conditions governing the annealing could be studied at temperatures above and below the critical point of the iron used. The sections were placed in the furnace when at the desired temperature, and heated for ½ hr. or 2½ hr., after which they were withdrawn from the furnace and cooled in air. Other specimens were heated for the same periods at the same temperatures, but cooled at different rates, namely, "slow cooling," approximately 3 deg. C. per min., and "very slow cooling," approximately 1 deg. C. per min. The critical points for the two irons were determined as follow:—

	Ac Point.	Ar Point.
Iron *A*	776° C.	721° C.
Iron *B*	792° C.	737° C.

Microscopic examination and combined-carbon determinations were conducted on the heat-treated samples in order to follow the changes which occurred. The combined-carbon determinations were obtained by difference, following the estimation of the total-carbon and graphite contents by combustion. The results obtained for combined carbon are given in Table I.

TABLE I.—*Combined-Carbon Contents of the Two Irons after Various Treatments.*

Iron.	Soaking period.	Air-cooled.	Slow cooling.	Very slow cooling.	As-cast.
Soaking temperature, 700 deg. C.					
		Per cent.	Per cent.	Per cent.	Per cent.
A ..	½ hr.	0.56	0.56	0.53	0.70
	2½ „	0.32	0.23	0.29	
B ..	½ hr.	0.49	0.51	0.53	0.56
	2½ „	0.18	0.19	0.16	
Soaking temperature, 900 deg. C.					
		Per cent.	Per cent.	Per cent.	Per cent.
A ..	½ hr.	0.80	0.78	0.65	0.70
	2½ „	0.90	0.75	0.58	
B ..	½ hr.	0.76	0.71	0.52	0.56
	2½ „	0.81	0.66	0.41	

Effect of Heat-Treatment

Examination of these figures shows that the combined-carbon content tends to decrease with an increase in soaking time at 700 deg. C., but increases with an extension of the annealing period at 900 deg. C. Considering the specimens annealed for the 2½-hr. period, it would appear that the subsequent rate of cooling is without effect on the removal of combined carbon when the heating temperature is 700 deg. C., but for an annealing temperature of 900 deg. C. a decrease in the subsequent rate of cooling brings about a drop in the combined-carbon content. This is shown graphically in Fig. 1. Fig. 2 shows the variation in Brinell hardness for the same specimens, and confirms the above findings. Microscopic examination gave additional confirmation. Figs. 3 to 10 illustrate the structures of the slowly-cooled specimens after heating for ½ hr. and 2½ hr. at 700 and 900 deg. C.

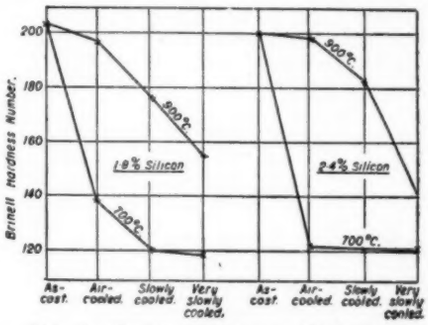

FIG. 2.—EFFECT OF RATE OF COOLING ON BRINELL HARDNESS.

Very little difference was detected between the microstructures of the as-cast bar A and the corresponding bar after annealing at 700 deg. C. for ½ hr. followed by slow cooling. The specimen annealed for 2½ hr. at 700 deg. C., however, had an almost entirely ferritic matrix, with small amounts of coalesced pearlite round the phosphide eutectic.

Specimens from the same bar heated at 900 deg. C. for ½ hr. contained a completely pearlitic matrix, but the pearlite was of a finer lamination than that of the as-cast bar. Annealing at 900 deg. C. for 2½ hrs. produced only a little ferrite round the graphite flakes, the pearlite still being very fine.

Somewhat similar changes were noticeable in the specimens from bar B, but in this case a fair amount of ferrite was present in the bar

* Report on a research carried out with the aid of a grant from the Andrew Carnegie Research Fund. It has been prepared as a Paper for presentation to the forthcoming autumn meeting of the Iron and Steel Institute.

annealed at 700 deg. C. for ½ hr. The remaining pearlite was in a coalesced form and concentrated round the phosphide eutectic. Annealing for the longer period of 2½ hrs. at 700 deg. C. was sufficient to remove all but traces of the pearlite.

Those specimens annealed at 900 deg. C. again showed a finely laminated pearlite with a steel-like appearance. Small amounts of ferrite were present near the graphite in the sample annealed for ½ hr. and larger amounts in those annealed for 2½ hrs. Very little difference in the character of the microstructure was noticed in the bars after 2½ hrs. anneal at 700 deg. C., followed by the different cooling rates. In all cases, the structures were similar to those illustrated in Figs. 4 and 8.

Effect of Soaking Time

From these results, it is apparent that for temperatures below the critical point, the time occupied at the soaking temperature is of the greatest importance in removing pearlite. Half an hour was considered to be more than sufficient time at 700 deg. C. and 900 deg. C. for the whole of the ½-in. section to be uniformly heated, and this surmise was substantiated by the uniformity of the structures of the bars.

Comparing Figs. 3 and 4, and 7 and 8, illustrating the structures of bars heated at 700 deg. C., it would appear that the increase in silicon content facilitates the removal of pearlite. When the annealing is carried out at a temperature above the critical point, a different condition arises. In this case, the time of soaking plays little part in the removal of the pearlite; in fact, a longer time may tend to increase the combined-carbon content. The rate of cooling after soaking is of major importance, the slower the rate of cooling, the greater being the amount of pearlite which is decomposed.

	Ac point. Deg. C.	Ar point. Deg. C.
Iron 1	816	765
„ 2	786	731
„ 3	764	708

FIG. 3.—BAR A HEATED ½ HR. AT 700 DEG. C. SLOWLY COOLED. × 200.

FIG. 4.—BAR A HEATED 2½ HRS. AT 700 DEG. C. SLOWLY COOLED. × 200.

FIG. 5.—BAR A HEATED ½ HR. AT 900 DEG. C. SLOWLY COOLED. × 200.

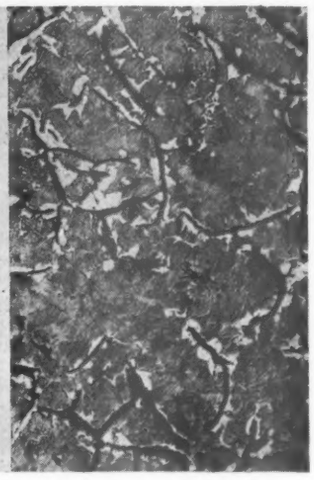

FIG. 6.—BAR A HEATED 2½ HRS. AT 900 DEG. C. SLOWLY COOLED. × 200.

Decomposition of Combined Carbon

Following this preliminary work, an attempt was made to study in more detail the rate of formation and decomposition of combined carbon in grey cast iron. For this purpose, three irons of the compositions given above were obtained in the form of 1.2 in. dia. bars.

The critical points for these irons were determined as shown at the head of column 3.

Half-bars from each of these samples were annealed to remove as much of the combined carbon as possible. The treatment given consisted of a 2-hr. soaking at 850 deg. C., followed by slow cooling. In this way three further sets of bars, designated 1A, 2A and 3A, were obtained, having the same composition as those given above, but with lower combined-carbon contents.

	T.C.	C.C.	G.C.	Si.	Mn.	S.	P.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Iron 1 ..	3.30	0.79	2.51	3.25	0.80	0.069	1.12
„ 2 ..	3.45	0.83	2.62	2.20	0.71	0.054	1.10
„ 3 ..	3.40	0.87	2.53	1.30	0.72	0.050	1.10

FIG. 7.—BAR B HEATED ½ HR. AT 700 DEG. C. SLOWLY COOLED. × 200.

FIG. 8.—BAR B HEATED 2½ HRS. AT 700 DEG. C. SLOWLY COOLED. × 200.

FIG. 9.—BAR B HEATED ½ HR. AT 900 DEG. C. SLOWLY COOLED. × 200.

FIG. 10.—BAR B HEATED 2½ HRS. AT 900 DEG. C. VERY SLOWLY COOLED. × 200.

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(To be continued.)

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The Spectroscopic Analysis of Steels*

By A. FISHER (Metallurgist, Magnesium Elektron, Limited)

Spectroscopic methods of analysis of metals, as distinct from spectrographic methods, are used where the most rapid results are required. To look through the eyepiece of a spectroscope and compare the spectrum seen with that drawn out or photographed on a chart is, of course, quicker than exposing and developing a photographic plate and taking micro-photometric readings of line intensities for later comparison, even if the plate be developed after only the one exposure without waiting for a further dozen or so exposures to fill up the remaining space on the same plate. Compared with ordinary chemical methods of analysis, the speed with which results may be obtained is of an entirely different order—minutes instead of hours, in fact.

Visual methods of spectra comparison do not give quite such accurate results as spectrographic methods, and are therefore used more for identification and general classification purposes than for very accurate routine analyses. The speed, however, when the method is regularly operated by a trained youth or laboratory assistant, is really remarkable. For instance, in steel analysis, the presence and closely approximate content of manganese, chromium, vanadium, molybdenum, cobalt, titanium, copper, tungsten and other elements can be determined in a few minutes. When comparison charts for the various elements are available, the operation is one that can be performed by any intelligent boy.

Modus Operandi

The spectroscopic analysis of steels is exactly the same in principle as that of any other material. By means of an electric arc struck between electrodes consisting one of pure iron, the other of the steel to be analysed, the various elements in the steel are vaporised and the light emitted from the incandescent vapour is examined by means of a narrow slit, a collimator, a prism or prisms, and a telescope, arranged in that order conveniently in one instrument, the elements together comprising a spectroscope.

The light emitted from any vaporised metal is uniquely characteristic of that metal inasmuch as it consists of ether vibrations of certain definite frequencies, and from large numbers of careful measurements made by many investigators, reference tables of corresponding wavelengths and line intensities for each metal have been compiled. The ether vibrations are originated by the intense heat generated in the arc causing some of the electrons in the atomic system of the vaporised metal to jump out to abnormal orbits. On returning to lower orbits, light energy is given out in the particular wavelengths involved in the relations between the various orbits concerned. It will be evident, therefore, that as every metal has its characteristic numbers of electrons and orbit relations, an analysis of the light emitted by means of the slit, prism, etc., producing a line spectrum, will enable positive indentification of any metal to be made.

Appearance of Spectrum

The spectrum of a metal appears, on looking into the eyepiece of a spectroscope, as a dark horizontal band crossed by a number of brilliantly coloured lines of different intensities. The colours extend from violet, through blue, green, and citron, to red. On an instrument of low deviation and dispersion—one with a single prism, for example—the whole of the spectrum from violet to red can be seen simultaneously. On an instrument of high deviation and dispersion, say one of five prisms, the whole field of view at one instant may consist of lines of apparently only one colour. On such an instrument line separation and analysis is greatly facilitated.

As each pure metal has its own characteristic spectrum consisting of particular series of differently coloured lines of certain relative intensities at certain relative distances from each other it will not be difficult to see that the presence of the vapour of a stranger metal in the arc—the metal being introduced either as an alloying element in the electrode or externally by insertion into the arc—will cause, by the same process as with the basis electrode metal, another different series of lines to appear superimposed on the spectrum of the basis or reference electrode metal.

How Determinations are Made

For instance, suppose two pure iron electrodes have been used, the pure iron spectrum will have been produced. If now one electrode be replaced by a piece of ordinary mild steel, the presence of the manganese in the steel will cause additional lines to appear in the iron spectrum at certain unchangeable positions. The intensity of these manganese lines, in relation to the intensity of the neighbouring iron lines, will have a certain value according to the manganese content in the steel, and by estimating the relative intensities of the manganese and iron lines as seen, as against those laid down on a comparison chart for the same metals, an estimate may be made of the manganese content in the mild steel. The comparison chart for manganese in steel is constructed by plotting from the spectra of steels of known manganese content, spectrum charts showing the relative intensities of the iron and manganese lines for the various manganese contents. Similarly with other elements.

The accuracy of spectroscopic determination for most elements is about 20 per cent. of the content. The difference, for example, between a manganese content of 0.4 and 0.5 per cent., or between 0.2 and 0.25 per cent., could be distinguished. There would thus be not the slightest difficulty in separating, say, a non-distorting high-carbon tool steel of 1.3 per cent. manganese content, from a straight high-carbon standard tool steel of 0.40 per cent. manganese, should these have become accidentally mixed in the tool-room steel stores—a frequent occurrence in some factories, it is feared. The test could be carried out in less than one minute.

Care of Alloy Steels

Again, the sensitiveness of the method for the qualitative determination of some elements is very high—for chromium and vanadium, for example; should two non-distorting type tool steels have become mixed, one of the ordinary high-carbon—high-manganese type and one of the high-carbon 1 per cent. chromium type, these could be separated immediately by means of the chromium lines which would show quite strongly in the latter, but much less strongly in the former, which would have a chromium content of, say, 0.25 per cent., and perhaps less. For the same reason, a carbon vanadium steel can easily be picked out from straight carbon steels, although the vanadium content is usually of the order of only 0.20 per cent. Similarly, manganese molybdenum, chromium carbon, chrome vanadium, chrome molybdenum, copper carbon and carbon tungsten steels are all quite simply and fairly accurately (quantitatively) dealt with. In the high-speed, high-chromium, nickel-chromium, or nickel steels, the high alloy content and number of alloying elements make accurate quantitative analysis difficult, although qualitatively it is simple. In the nickel steels, the nickel lines—even the most sensitive—do not show with less than 1 per cent. of nickel, and visual analysis is not easy below 3 per cent.

Essential Requirements

The apparatus required depends on the available electric supply. D.C. is essential, as metal electrodes will not work on A.C. If, therefore, only A.C. is available on the line supply, a motor generator or rectifier and choke will be required. Ten amps. at 110 volts will suffice for any requirements, and a series resistance with variation from 12 to 25 ohms in five steps is necessary. An ammeter and voltmeter should be placed in the circuit.

The operation of the arc is simplicity itself. The resistance should be adjusted so that the current varies according to the diameter of the specimen, allowing 1 amp. for each $\frac{1}{10}$ in. dia., or thereabouts. The open arc will take about two-thirds of the current flowing with contacting electrodes. The arc can then be struck and the electrodes immediately separated about 0.25 in. After, say, 30 secs., a bead will have formed and the arc will have steadied sufficiently to be examined. It will be found beneficial to adopt standard times for arcing before examination of the spectrum. Actually 30 secs. is generally sufficient for most elements, but for nickel, two minutes will be found to give more reliable results.

Trouble is sometimes caused by a wandering flame, and may be avoided by setting the electrodes so that the flame emerges on the opposite side to that from which the observation is being taken.

It is, of course, essential that the "business end" of the electrodes be uncontaminated. It is unnecessary to use a condensing lens between the arc and the slit, but the latter should be protected from dust and metallic splash by a thin piece of glass of good quality, such as a standard microscope-slide cover glass. The slit should be at a distance of a few inches to a foot from the arc.

The Apparatus

With regard to the spectroscope itself, a two-prism instrument is generally satisfactory if the prisms are made of dense glass of high refractive index—say 1.65 to 1.70; as the collimator and telescope tubes are then approximately at right angles to each other, observations can conveniently be made without dazzle from the arc. The writer uses at the present time a five-prism instrument, the observation tubes again being approximately at right angles, the deviation being of the order of 270 deg. and the light path crossing over itself. Lines only a tenth of an Ångström unit apart can be easily separated in the blue, and observation is therefore very comfortable. The prisms are Hilger first-quality units 2¼ in. length of side and the spectrum seen is everything that can be desired.

* Extracted from "Wild-Barfield Heat-Treatment Journal."

Rust-Preventing Paint

Kemick, a chemical rust-preventing paint for metal surfaces that are subject to high temperatures, is announced by American Chemical Paint Company, Ambler, Pa. It sticks to the metal even when it gets red hot. When heated, the paint decomposes, volatiles are expelled and chemicals liberated to react on the metal surface, becoming part of it and neutralising rust-producing agents. It is suitable for use on steel, iron, copper, brass, aluminium, zinc or galvanised iron, and is applied by brush or spray. Its colour, when first applied, is black. After being heated it retains a dark-grey tone.

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W.53

The Week's News in Brief

Trade Talk

THE RHODNEL ENGINEERING COMPANY, LIMITED, is being wound up voluntarily. Mr. G. E. Innes, 16, Clegg Street, Oldham, is the liquidator.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, has declared an unchanged quarterly dividend of 50 U.S. cents per common share.

SHEFFIELD CUTLERY MANUFACTURERS, it is understood, have been informed that stainless steel will in future be available only for export trade.

IN ORDER to meet the increasing demand for native iron ore preparations are in hand to reopen another Cleveland mine which has been idle for a number of years.

FOLLOWING THE RETIREMENT of Mr. James Taylor, the Wellman Smith Owen Engineering Corporation, Limited, have appointed Gilmoursmith (Engineering), Limited, 136, Renfield Street, Glasgow, C.2, to represent them in Scotland.

UNEMPLOYED MEN in reserved occupations will in future be free to join any of the services of national defence (including the civil defence services), unless suitable employment upon important work in industry can be found for them at once, or it is known that such employment will be available at an early date.

JAMES NIMMO & COMPANY, LIMITED, has made an offer to supply Glasgow Corporation with surplus gas from their coke-oven batteries, amounting to 500,000 cub. ft. per day at the outset, increasing this later to 1,500,000 ft. per day, under a similar price arrangement to that entered into by the Corporation with Wm. Dixon, Limited.

AN ORDER which will ensure a check on all prices charged for second-hand machine tools has just been signed by Mr. Herbert Morrison, Minister of Supply. The Order requires all secondhand machine tool dealers to register with the Ministry, and to keep a register of their dealings in these tools. On and after August 17 no dealings will be authorised except under licence granted by the Minister of Supply. The Order also limits dealers' sales to sales to Government departments and other bona-fide users.

THE LECTURES comprised in the Industrial Welfare Society's Correspondence Course in Industrial Law have been brought up to date with recent legal changes. With the entry into factories of more persons on the labour and personnel management side the course serves a useful purpose in providing them with the necessary knowledge of the legal principles affecting their work. One of the main advantages is that the course does not presuppose previous legal training on the part of those taking it and the various points are explained in non-legal language. Particulars are available on application to the Secretary, Industrial Welfare Society, 14, Hobart Place, Westminster, London, S.W.1.

POLBERRO TIN, LIMITED, of Cornwall, announces that its consulting engineer has submitted certain recommendations, including in particular the provision of additional labour and finance and intensive development in the south section of the property, including the accentuation of work on recent favourable discoveries in this section, with a view to augmenting the supply of profitable ore for the ultimate full-time operation of the mill. The directors have approached the three principal shareholders and made representations to the appropriate Committee of the Ministry of Supply with a view to obtaining the additional finance required to carry out the recommendations of the consulting engineer.

THE TATA IRON & STEEL COMPANY is reported to be considering a scheme which would replace the existing deferred shares by the issue of additional ordinary shares. The conversion would be made on a basis equitable to both categories of shareholders, and would not involve any cash payment. At present, deferred shares amount to Rs. 14,62,500 and ordinary shares to Rs. 2,62,50,000. In addition, there is an issue of Rs. 75,00,000 of 6 per cent. preference shares and Rs. 7,00,00,000 7½ per cent. preference shares. Under existing arrangements, ordinary and deferred shares are entitled to non-cumulative dividends of 8 per cent. and 25 per cent. respectively, after preference dividends have been paid. Any further profit is distributed equally between the ordinary and deferred shares.

Personal

SIR EDWARD CROWE has been appointed a director of the English Electric Company, Limited.

MR. ERNEST HAWLEY GREEN has completed 50 years' continuous service with Kitson & Company, Limited, engineers, of Airedale Foundry, Leeds. He is secretary and joint general manager of the firm.

MR. C. H. KAIN, foundry manager, Lake & Elliot, Limited, Braintree, has been presented with a silver cigarette box by the Council of the London Branch of the Institute of British Foundrymen, on the occasion of his marriage.

FOREMEN AND EMPLOYEES in the patternmaking department of Glenfield & Kennedy, Limited, Kilmarnock, met in the canteen recently to honour two of their colleagues on their retirement. Mr. H. Fulton received two occasional chairs after more than 50 years' service, and Mr. M. Gibson was recipient of a wallet of notes.

MR. THEODORE J. KAUFFELD, who has been appointed manager of the Products Division of American Type Founders, Inc., of Elizabeth, New Jersey, came to England in 1936 as consultant to the Alfa Laval Company, Limited, of London, which was awarded a $1,000,000 contract in connection with the erection of the large new steel plant for Richard Thomas & Company, Limited. He was subsequently chairman of the board and managing director of the Inter-Continental Engineering Company, Limited, of London. Owing to war conditions, Mr. Kauffeld has now returned permanently to the United States.

Wills

GIBBINS, DAVID, of Birmingham, engineer and ironfounder	£57,697
BAINBRIDGE, H. W., of Leamington Spa, iron and steel merchant	£69,134
BEARE, SIR THOMAS HUDSON, Regius Professor of Engineering at Edinburgh University	£2,029
BRAITHWAITE, W. H., director of Braithwaite & Company, Limited, engineers, of Leeds	£4,143

Obituary

THE DEATH has occurred of Mr. Roger Wood, of John Wood & Sons, Limited, colliery engineers and ironfounders, Barley Brook Foundry, Wigan. Mr. Wood was 74 years of age and had been in failing health for several months.

Iron and Steel Scrap

Speaking in the House of Commons recently, MR. T. SMITH asked the Minister of Supply whether he was satisfied that there was no bottleneck in the supplies of scrap metal reaching the steelworks and foundries; that it was in the public interest that steelworks supplies should reach them only through the National Federation of Scrap Iron and Steel Merchants, and that officials of this Federation should hold important positions at the Ministry.

MR. H. MORRISON, in reply, referred to the statement published in our last issue (page 96). He added that he was satisfied that there was no bottleneck in the flow of scrap metal to consumers, apart from that created by labour and transport difficulties, and that it was in the public interest that there should be a responsible organisation of employers within the scrap industry, particularly in connection with the solution of the labour problem. Moreover, a policy of letting everybody do as they liked in moving and allocating scrap would be contrary to the public interest. It was necessary in dealing with these highly technical matters to employ experts from the industries concerned in the various Controls, but these temporary officials severed any active connection with their businesses while serving with the Controls. He was continuing to keep a close watch on the whole scrap position.

Reports and Dividends

Richardsons Westgarth & Company, Limited—Dividend of 7½ per cent. on the ordinary shares for the year ended March 31 last.

Vickers, Limited—The interim dividend of 2½ per cent. on the cumulative preference stock, payable August 23, is free of tax up to 6s. in the £ only.

Wellman Smith Owen Engineering Corporation, Limited—Net profit for the year to March 31, £79,793; tax provision, £40,000; final dividend of 5 per cent. and a bonus of 2½ per cent., making a total of 12½ per cent.

Siemens Bros. & Company, Limited—Profit for 1939, £306,234; brought in, £365,627; dividend on the 10 per cent. cumulative preference stock, £55,000; to general reserve, £60,000; dividend of 7½ per cent. on the ordinary stock, £183,750; carried forward, £373,111.

Electric Furnace Company, Limited—Net profit for the year ended March 31, £48,802; brought in, £3,130; dividend of 7 per cent. on the cumulative preferred ordinary shares, £5,984; dividend of 7 per cent. on the ordinary shares, £5,477; E.P.T. and income tax, £24,000; reserve for depreciation of investments, £8,570; final dividend of 3½ per cent. on the ordinary shares, £2,739; carried forward, £6,650.

Warner & Company, Limited—Trading profit for the year to June 30, £10,646; income from investments, £810; brought in, £159; arrears of preference dividend for half year ended June 30, 1938, £877; A.R.P., £137; income tax, £48; E.P.T., £4,000; provision for anti-glare expenditure, £1,250; depreciation, £1,750; arrears of preference dividend for year ended June 30, 1939, £1,552; carried forward, £1,644.

Hours in Munitions Works

Men and women workers in aircraft and engineering establishments have been working long hours and putting in all their energy since the withdrawal from Dunkirk. It is obvious that the strain cannot be continued without loss of both efficiency and production. The working week has ranged from 70 hours to 80 hours. Mr. Ernest Bevin, Minister of Labour and National Service, is sending to all employers concerned a circular explaining how working time may be cut down to 55 or 56 hours a week for men, though, for a time, until a sufficient labour force is available, the hours may have to average 60. During this interim period employers are advised to engage relief workers. An interim reduction of working hours for men to 60 on day shifts—58 one week and 62 the following week—with night shifts of 10½ hours for five nights, with a sixth added fortnightly if required, is suggested. These hours do not include meal times. Until the necessary additional labour force has been obtained relief workers should be called in to take the place of unskilled or semi-skilled workers on rest days—if possible for two day and two night shifts. The relief workers would be a training squad for new staff if extensions are contemplated. To obtain relief workers employers should apply to the local labour supply committee.

As soon as the additional labour force has been obtained and trained it is recommended that employers should adopt a permanent scheme to bring working hours to 55 or 56, to increase the numbers employed so as to fill up all the possible hours of work, and also to increase the output for each man-hour worked. To increase the labour force the Ministry's training scheme is being expanded to raise the numbers to a rate of 400,000 a year, and it is expected that this rate will be reached by the end of the year. The Minister has made a general Order for engineering and certain other classes of works which permits employers who obtain written permission so to do to arrange three-shift sytems for women and youths over 16, or extended day work (not exceeding 60 hours). To meet an exceptional emergency a seven-day week may be authorised. It has already been announced that the Minister was making an Order requiring the occupier of any named factory to make arrangements for part or whole-time doctors, nurses, and officers to supervise the welfare of the persons employed. The Order is now in force.

REFRACTORIES ON PARADE

THE TECHNICAL KNOWLEDGE GAINED FROM RESEARCH IS AVAILABLE TO ALL USERS OF SANDS AND REFRACTORIES FOR THE FOUNDRY

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Raw Material Markets

The demand for iron and steel is such that no general stoppage can be made this year for holidays at the producing works, and, in order to allow workers to have some break, which the Government regards as essential, employees will take their vacations over a period of months, thus avoiding the customary closing down of the works. The only output lost now is in effecting essential repair work. Order-books among the heavy engineering concerns are almost entirely filled with work for Government departments, and supplies of iron to these works are being made satisfactorily. Little or no opportunity is afforded to accumulate stocks of iron, but licensed users are obtaining adequate tonnages to meet their week-to-week requirements. Light-castings foundries, while operating more fully than was the case a few months ago, are still, in a great many cases, unable to avoid short time. Their chief difficulty is that, generally speaking, iron cannot be made available to them for ordinary domestic work, while the tonnage released for the export trade is restricted. Thus, most of the peacetime outlets of this industry have disappeared and, as yet, only a comparatively small amount of Government work has taken their place. Official contracts are expected to increase steadily, while efforts now being made to resuscitate the export trade may help this section to some extent.

Pig-Iron

MIDDLESBROUGH—The demand for foundry pig-iron in the Cleveland district is expanding, but, for the time being, adequate supplies are being delivered from the Midlands producing works, although the position is being watched very carefully by the Control authorities, as there is little surplus after the needs of priority consumers have been met. The present position does not facilitate iron being made available for any other than priority work, but there should be little difficulty in expanding production if the need becomes really urgent. The full output of East Coast hematite is required for contracts of national importance, and consumption is running at a very high level. Where possible increasing use is being made of high-phosphorus iron in consumers' mixtures. The steelworks in this area are taking up the major portion of outputs, but fair deliveries are still being made to users in Sheffield and the Midlands. Export business cannot be entertained at the present time.

LANCASHIRE—Consumption of foundry pig-iron was slightly less last week, as, although there was no general stoppage at the consuming works, some concerns closed for a few days to carry out plant renovations. On the whole, however, there is brisk activity in almost all sections. If anything, the light-castings foundries are now better employed, but satisfactory returns still have to be reported by this branch, which has been adversely affected by the virtual cessation of peacetime work. Derbyshire and Staffordshire ironworks are despatching iron to this district on quite a good scale, but it is hoped that some improvement will be possible in the near future, as it is expected that two Midlands furnaces which were placed on the production of basic iron some time ago will shortly be transferred to the manufacture of foundry qualities. Hematite consumption is substantial, and large tonnages of West Coast material are being called for.

MIDLANDS—The production of both low-phosphorus iron and hematite is taxed to its limits, and unless some improvement can be brought about it may become necessary for supplies of these grades to be imported. The Control authorities are naturally reluctant to adopt this course, and every effort will be made to satisfy the needs of consumers on Government work from home outputs. In some cases it is possible for users to adjust their mixtures and make additional use of high-phosphorus iron, but there are certain obvious difficulties in this respect. The demand for high-phosphorus iron has recently increased, and distribution calls for considerable care; buyers have to furnish proof that their need is urgent before the Control will grant the necessary licence. It is felt that the present system of allocation is quite fair as a wartime measure, and trade circles are co-operating closely with the authorities.

SCOTLAND—Although it is not possible to lay down stocks of iron, fair tonnages are coming forward to meet the needs of the heavy engineering concerns, which are engaged almost solely on contracts issued by various Government departments. The position of light-castings makers in the Falkirk district continues to improve, despite the fact that many works are not yet fully employed. In some cases, where plant has been adapted to cope with work of national importance, good results are reported. There is a particularly strong call for steel-making iron and makers are being pressed for heavy deliveries.

Coke

Most consumers of foundry coke are now covered by contracts over several months, and many foundries have taken the opportunity of putting down reserve stocks, as deliveries have been quite satisfactory to meet more than current requirements. Prices are controlled and the present minimum figure is 55s. 6d. per ton, delivered Birmingham and Black Country stations.

Steel

Full use is being made of the resources of the British steel industry, but imports of American ingot steel and semis are arriving at United Kingdom ports to supplement home production. Since the allocation of steel supplies was taken over by the Control there has been considerable improvement in deliveries, as makers have been relieved of the difficult problem of discriminating between the character of consumers' needs. As a wartime measure it is appreciated that this system represents a considerable contribution to the success of the industrial war effort. Increased supplies of raw materials have enabled some producers to record heavier outputs recently, but there is need for every ton which can be made available. While all descriptions of steel are in heavy demand at home, it is hoped that larger tonnages will be placed at the disposal of overseas consumers later, as there is a considerable amount of foreign inquiry on the market. In addition, there is much work of a domestic character waiting to be dealt with at home.

Scrap

Good deliveries of scrap iron and steel continue to be made to consuming works, but there is an outlet for all that can be collected and it is necessary to maintain, and even increase, the present supply. Replying to questions in the House of Commons last week, the Minister of Supply stated that he was already using his powers to requisition scrap iron and steel whenever this appeared to be necessary or desirable. Mr. Morrison added that disused railway tracks were being taken up for scrap wherever possible, though it might be desirable in certain cases to maintain such tracks in being even if they were not at present being used. He was in touch with the Minister of Transport on this subject and with the Secretary for Mines on the question of utilising old tracks in mines and quarries.

Metals

There can be no doubt that consumption of copper in this country is steadily increasing. Supplies appear to be very satisfactory, and priority users are acquiring sufficient metal to enable them to operate to full capacity. Some indication of the situation has been furnished by the recent decision of the Government to expand the export of products involving the use of copper and other metals. This is especially gratifying, as consumption is likely to expand still further with the opening up of new plants from time to time. In the United States, demand for copper has been rather quieter of late. Many consuming works are operating on a lower scale owing to holiday interruptions, but it would appear certain that the American rearmament programme will shortly have a stimulating effect on working-up industries.

The tin market both at home and in the United States is on the quiet side. Despite the heavy buying programme of the U.S. Government, adequate supplies are available to ordinary buyers, who have only to quote slightly above the official buying price of 50 cents in order to satisfy their requirements.

An appeal has been made by Empire tin producers to Sir Kingsley Wood, Chancellor of the Exchequer, for relief from 100 per cent. excess profits tax. They urge that the tax unfairly penalises the exploitation of wasting assets and cripples future development. The appeal embodies a resolution passed by the Tin Producers' Association's executive committee, which points out that most Empire tin is produced from alluvial mines with lives limited to between six and eleven years. It is emphasised that alluvial tin mines have a life five to ten times shorter than many other mineral properties such as coal. Thus, the application of 100 per cent. E.P.T. in its proposed form means that the whole of the output of tin from such mines in excess of that amount which will allow the profits earned in the standard year will earn nothing for the majority of producers.

London Metal Exchange tin prices this week have been as follow:—

Cash—Thursday, £265 15s. to £266; Friday, £265 to £265 5s.; Monday, £264 to £264 5s.; Tuesday, £263 to £263 5s.; Wednesday, £263 to £263 10s.

Three Months—Thursday, £265 15s. to £266 5s.; Friday, £265 5s. to £265 10s.; Monday, £264 10s. to £265; Tuesday, £263 15s. to £264; Wednesday, £263 15s. to £264.

Adequate supplies of spelter are forthcoming to meet the needs of priority users in the United Kingdom, while there is also metal available under licence for other users at home as well as for export. Lead, too, is available for export and progress in this connection is reported, especially with regard to the paint trade.

Aluminium and Silicon Control

Responsibility for the control of aluminium has been transferred from the Minister of Supply to the Minister of Aircraft Production, who has made the Control of Aluminium (No. 5) Order, 1940, which came into force yesterday (Wednesday). The new Order repeats the main provisions of the existing Order, subject to certain modifications. In particular a licence is required for the treatment, use, or consumption of aluminium scrap and aluminium alloy scrap save for the purpose of converting it into ingots. The grinding of foil scrap to produce powder and the "destructive" use of scrap for such purposes as steel de-oxidation or the manufacture of aluminium bronze are now subject to licence. The cleaning, crushing, bulking and sorting of scrap in the course of collection and merchanting continue to be exempt from licence. All acquisitions of aluminium and aluminium alloy and all disposals of aluminium and of aluminium alloy must be effected under licence. Licences will not be granted to anybody to acquire or dispose of aluminium or aluminium alloy simply for the purpose of dealing in it.

The Ministry of Aircraft Production will also be responsible for bauxite, cryolite and silicon metal. The Control of Silicon (No. 1) Order, 1940, provides that silicon metal (*i.e.*, material containing not less than 97 per cent. of silicon) shall not be bought, sold or used except under licence.

U.S. Manganese Plants

Under a national defence measure, the U.S. Bureau of Mines receives discretionary authority to erect and operate more than one pilot plant for the beneficiation of manganese ore. In its original form the measure provided for only one such plant. It was then proposed that the Government erect a plant with a daily capacity of 50 tons. It is estimated that the U.S. will consume probably 1,000,000 tons of manganese ore during the next 12 months. The American Manganese Producers' Association points out that the industry now stands in need of encouragement to develop its mines and concentrate its ores to the proper grade; concentrating and beneficiation plants could be established at central points in producing areas throughout the country, it is urged, and high- and low-grade ores produced and blended or beneficiated to required specifications, in a comparatively brief length of time.

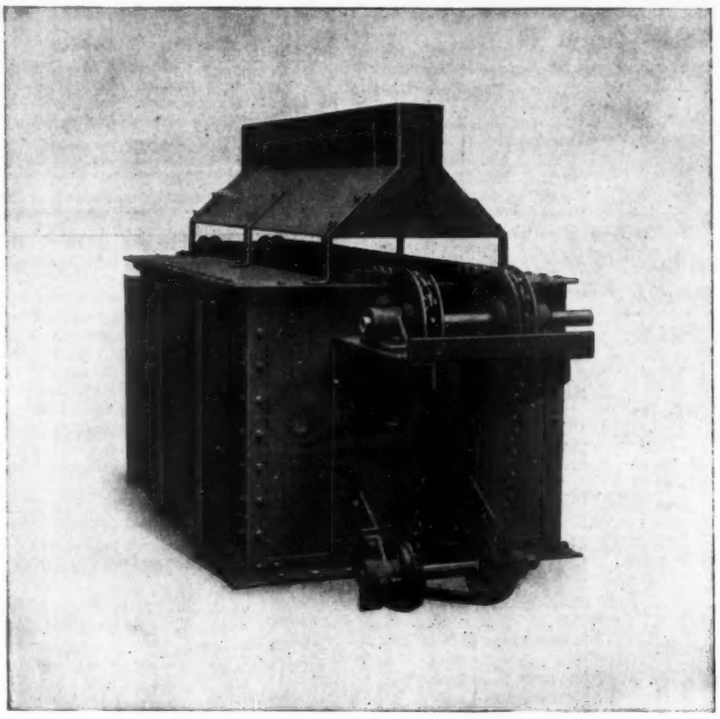

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Illustration shows oil-fired furnace, but any type can be arranged to suit requirements.

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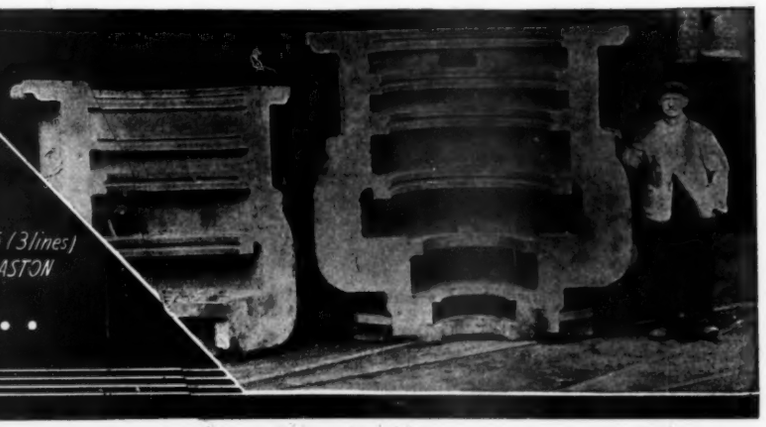

RAW MATERIALS—PRICE LIST

Wednesday, August 14, 1940

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent.	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

	£	s.	d.
Standard cash	263	0	0
Three months	263	15	0
Settlement	263	5	0
Official average Cash, July	265	15	2 1/23
Do. Three Months, July	265	9	4 4/23
Do. Settlement, July	265	14	6 18/23

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western"	26	10	0
Refined and electrolytic	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b.	30	0	0
Pipes, home	34	0	0
Do. export, f.o.b.	30	10	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises	28	7	6

ANTIMONY

	£	s.	d.
English, 99%	90	0	0
Foreign Regulus, duty paid	99	0	0
Chinese, prompt shipment, c.i.f.	80 0 0 to 83	0	0

QUICKSILVER

	£	s.	d.
Quicksilver, ex-w'hse London	54	10	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 3s. 0d.
Finished bars, 18% tungsten 3s. 10d.
Finished bars, 22% tungsten 4s. 4d.
Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/– to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

(all prices nominal)

	£	s.	d.
Ferro-silicon—			
25%	18	10	0
45/50%	21	10	0
75%	31	0	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/– lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	—		
Max. 1% car.	—		
Max. 0.5% car.	—		
70% carbon-free	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	0	0
76/80% packed	19	10	0
Metallic manganese—			
94/96% carbon-free	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths	3	16	6	to 3	19	0
Heavy machinery cast iron			4	6	6	
Ordinary heavy cast iron			4	1	6	
Cast-iron railway chairs			4	6	6	
Medium cast iron			3	17	9	
Light cast iron			3	13	0	
MIDDLESBROUGH—						
Short heavy steel	3	14	3	to 3	16	9
Heavy machinery cast iron			4	11	3	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	8	9	
Medium cast iron			3	19	0	
Light cast iron			3	14	0	
BIRMINGHAM DISTRICT—						
Short heavy steel	3	9	3	to 3	11	9
Hematite ingot mould			5	10	9	
Heavy machinery cast iron			4	11	9	
Ordinary heavy cast iron			4	7	0	
Cast-iron railway chairs			4	7	0	
Medium cast iron			3	19	9	
Light cast iron			3	14	9	
SCOTLAND—						
Short heavy steel	3	14	0	to 3	16	6
Heavy machinery cast iron			4	13	9	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	13	9	
Medium cast iron			3	16	9	
Light cast iron			3	11	9	

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 2s. per ton, plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra.

PIG-IRON*

N.E. COAST (d/d Tees-side area)—	
Foundry No. 1	123/–
„ No. 3	120/–
„ No. 4	119/–
Forge No. 4	119/–
Hematite No. 1	131/–
Hematite M/Nos.	130/6
N.W. COAST—	
Hem. M/Nos. d/d Glas.	131/–
„ d/d Birm.	142/6
MIDLANDS (d/d Birmingham dist.)—	
Staffs No. 4 forge	121/–
„ No. 3 fdry.	122/–
Northants forge	118/6
„ fdry. No. 3	119/6
„ fdry. No. 1	122/6
Derbyshire forge	121/–
„ fdry. No. 3	122/–
„ fdry. No. 1	125/–
Phosphorus 0.5% to 0.75%	129/6
Phosphorus 0.1% to 0.5%	132/6
SCOTLAND—	
Foundry No. 1, Grangemouth	119/9
„ No. 3, Grangemouth	117/3
Cleveland No. 3, Glasgow	123/–
„ „ Falkirk	120/–
Scottish hem. M/Nos. d/d	131/–
SHEFFIELD (d/d district)—	
Derby forge	118/6
„ fdry. No. 3	119/6
Lincs forge	118/6
„ fdry. No. 3	119/6
W.C. hematite	136/6
LANCASHIRE (d/d eq. Man.)—	
Derby fdry. No. 3	125/–
Staffs fdry. No. 3	125/–
Northants fdry. No. 3	123/6
Cleveland fdry. No. 3	125/–
Cylinder and Refined Irons	
North Zone	168/–
South Zone	170/6
Refined Malleable	
Birmingham and S. Staffs	165/6
Cold Blast	
South Staffs	217/–

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots	10	10	0
Tested, up to 0.25% C.	10	15	0
Tested, 0.25 to 0.33% C.	10	17	6
Tested, 0.33 to 0.41% C.	11	0	0
Hard (0.42 to 0.60% C.)	11	17	6
„ (0.61 to 0.85% C.)	12	7	6
„ (0.86 to 0.99% C.)	12	17	6
„ (1% C. and up)	13	7	6
Silico-manganese	14	5	0
Free-cutting	12	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	13	15	0
Case-hardening	14	12	6
Silico-manganese	14	10	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C.	12	2	6
Basic hard, 0.41 to 0.60% C.	12	10	0
Acid, up to 0.25% C.	14	5	0

Other Semi-products, etc.

Tin bars	10	7	6
Sheet bars	10	7	6
*Wire rods, soft basic	15	4	0
„ hard basic	18	12	6
„ free-cutting	17	12	6
„ acid	22	3	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections plates joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast)	14	3	0
Boiler plts. (N.E. Coast)	15	0	6
Chequer plts. (N.E. Coast)	15	13	0
Angles, over 4 un. ins.	13	13	0
Tees, over 4 un. ins.	14	13	0
Joists, 3 in. × 3 in. and up	13	13	0
Rounds and squares, 3 in. to 5½ in.	14	13	0
Rounds under 3 in. to ¼ in. (untested)	15	8	6
Flats—over 5 in. wide	13	18	0
„ 5 in. wide and under	15	8	6
Rails, heavy, f.o.t.	12	15	6
Hoops	16	3	6
Black sheets, 24 g. (4 t. lots)	19	7	6
Galv. cor. shts. („)	22	12	6
Galv. flat shts. („)	23	2	6
Galv. fencing wire, 8g. plain	24	7	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales	15	2	6
Scotland	15	2	6
Ireland, f.o.q.	15	15	0
No. 3 BARS:			
England and Wales	12	5	0
Scotland	13	7	6
Ireland, f.o.q.	12	17	6
No. 4 BARS:			
England and Wales	12	15	0
Scotland	13	12	6
Ireland, f.o.q.	13	7	6
STRIP:			
England and Wales	16	10	0
STAFFS MARKED BARS, f.o.t.	18	0	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated, July 16, 1940.

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
Wire rods	2.00
	Cents.
Iron bars, Chicago	2.25
Steel bars	2.15
Tank, plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., No. 24	3.80
Wire nails	2.85
Plain wire	2.00
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	42/6 to 44/–
„ furnace	31/6 to 33/–
Durham foundry	39/6
„ furnace	33/6
Scottish foundry	42/6 to 47/6
„ furnace	31/6

TINPLATES

f.o.b. Bristol Channel ports

I.C. cokes 20 × 14 per box	27/6 to 28/–
„ 28 × 20 „	55/– to 56/–
„ 20 × 10 „	40/– to 42/–
„ 18¾ × 14 „	30/–
C.W. 20 × 14 „	27/6
„ 28 × 20 „	55/–
„ 20 × 10 „	40/–
„ 18¾ × 14 „	29/–

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	8½d.

COPPER TUBES, etc.

Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	9½d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	13½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	17d.

Delivery 3 cwt. free.

10% phos. cop. £35 above B.S.

15% phos. cop. £40 above B.S.

Phosphor tin (5%) £40 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913 ‖	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 8 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 8 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	*	*	*	*	*	*	*	1 5 0	1 1 1½ ‖
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9½	0 14 6½	0 14 6	0 14 6	0 15 4	0 15 6½
1933	0 16 0½	0 15 11½	0 15 6½	0 15 6	0 15 6	0 15 6	0 15 6	0 15 8½	0 16 1½	0 17 0	0 17 6	0 18 0	0 16 1½
1934	0 19 4½	1 0 6	1 0 1½	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0
1935	1 0 0	0 19 6½	0 19 0½	0 19 0	0 19 0	0 19 0	0 19 0	0 19 0	0 18 9½	0 18 9½	0 19 5½	1 1 2½	0 19 3½
1936	1 2 0	1 2 11½	1 3 2½	1 4 0	1 4 11½	1 5 3½	1 5 1½	1 4 7½	1 4 6	1 4 6	1 4 6	1 4 6	1 4 1½
1937	1 5 6	1 5 10½	1 7 7½	1 12 9½	1 15 0	1 19 3½	1 18 6½	2 0 0	2 0 3½	2 1 10½	2 2 0	2 2 0	1 16 1½
1938	2 0 1½	1 16 7½	1 16 6	1 16 6	1 16 6	1 13 9½	1 11 11½	1 11 6	1 11 6	1 11 6	1 11 6	1 11 6	1 13 9
1939	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 13 0	1 13 0	1 8 10
1940	1 13 0	1 14 10½	1 15 6	1 15 6	1 15 6	1 15 8	1 16 11½	—	—	—	—	—	—

* Strike period. ‖ Five months.

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CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

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PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

MALLEABLE FOUNDRY MANAGER open for engagement now. Fully experienced in sole control of 150 staff. Hand and machine moulders, annealing, pattern and core shops, machine shops and assembly work. Estimating, costing and commercial side generally. Time study and modern production methods. Would also consider employment as consultant to firms commencing malleable production.—Apply, Box 426, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

ANALYTICAL CHEMIST required for Foundry engaged on high-duty Alloy Irons. Knowledge of Steel Analysis an advantage.—Write, giving full particulars and salary required, to Box 420, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

CHEMIST required for Steel Foundry on North-East Coast, accustomed to Tropenas Converter and Electric Furnace (Basic). State age, experience and salary required.—Box 428, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MANAGER required to take control of Core shops of a large Midland Foundry, engaged on mass production of Iron Castings. This position calls for a first-class man capable of organising and controlling about 200 male and female operators.—Write, giving full particulars and salary required, to Box 422, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

NON-FERROUS FOREMAN-MANAGER. Permanency suitable applicant. State age, experience and wages required.—Box 410, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

STEEL Foundry Charge Hand required for North Midlands district. One used to general steel castings up to 2 tons in weight. Must be thoroughly practical moulder with organising ability. State age, experience and wages required.—Box 414, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

TECHNICIAN WANTED by large modern Whiteheart Malleable Foundry and Engineering Works, engaged on Government work, in an evacuation area. Familiar with progressive hand and machine moulding, hand and blowing machine core making, cupolas, annealing ovens, pattern making, sand mixtures, etc. Preferably a qualified practical and technical engineering graduate with works experience. Permanency for the right man.—Apply, giving age, experience and salary required, to Box 412, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

TIME AND MOTION STUDY.—Young man required at a Foundry in the West Riding. Preferably with some previous experience and not liable for military service.—State qualifications and salary required to Box 418, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

WANTED, an Assistant Core-Shop Foreman for a Repetition Foundry making castings for the Motor and Allied Trades. Good prospects for a suitable man.—Write, giving age, experience and salary required, to Box 424, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

SITUATIONS VACANT AND WANTED—*Contd*

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

ASSISTANT FOUNDRY MANAGER requires similar position. Experienced in cast-iron and non-ferrous general engineering castings to Government specifications. British Foundry School Diploma. (386)

PATENT

THE Proprietors of the Patent No. 352745 for Attachment for cables, rods, wires or the like and method of securing the same to a cable or the like are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE LAKE & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

MACHINERY

MELTING FURNACES.

3 Cummings 100-lbs. capacity, coke-fired, self-contained crucible Furnaces.

2 Morgan 250-lbs. capacity "S" type oil-fired Tilters, centre-axis.

2 ditto, 600-lbs. capacity.

ALEX. HAMMOND,
14, Australia Road, Slough.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO. LTD., Station Works, Ecclesfield, Sheffield.

CUPOLAS

6 ft. dia., 10 tons per hr.
3 ft. 6 in. dia., 3 tons per hr.
2 ft. 6 in. dia., 15-cwt. per hr. Cupolette.

PNEUMATIC MOULDING MACHINES

Macdonald Jolter, table 72 in. by 54 in.
Tabor 16-in. Shockless, table 72 in. by 48 in.
Tabor Portable Shockless Rollover, table 40 in. by 30 in.
Tabor ditto, table 27 in. by 20 in.
Tabor 21 in. by 16 in. squeeze.
Zimmerman Type R.P.W.2 Jolt Squeeze turnover, table 36 in. by 20 in.
Mumford Type (Jackman) Swing Headpress, 13 in. by 15 in. and 14 in. by 16 in.
Mumford Pneumatic Core Jolters having 15-in. by 20-in. and 12-in. by 12-in. tables.
Britannia No. 1 "Coventry" Pneumatic Turnover Jarr Ram, table 30 in. by 28 in.
Rotoil Oil Sand Mixer.
50 Air Compressors; 500 Electric Motors, Dynamos, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD, LANGLEY,
Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD, LTD.

No. 3 Becker VERTICAL MILLING MACHINE; table working surface 28 in. by 10 in.; overall ditto, with approximately 24-in. power longitudinal, 8½-in. hand cross and 15-in. hand vertical travel; 3-step cone drive, largest cone 12½-in. diameter by 2½-in. face; 3 belt feeds.

Write for "Albion" Catalogue

ALBION WORKS, SHEFFIELD
'Grams: "Forward." 'Phone: 26311 (15 lines).

MACHINERY—*Continued*

FOR SALE, one Demonstration Laidlaw-Drew Oil-Fired Tilting Furnace, with Laidlaw-Drew low pressure oil firing equipment and Morgan 400-lb. crucible.—Price and particulars on application to LAIDLAW, DREW & CO., LTD., 9, Tower Street, Leith, Edinburgh, 6.

FOR SALE.—One Incandescent Gas Furnace, with four burners, size of Oven, 1 ft. by 1 ft. by 2 ft. deep. Pyrometer by Elliott Bros. & Company, Limited; nearly new; £55.—ERICSSON BROS., LIMITED, 154, West Street, Erith, Kent.

MISCELLANEOUS

"A STUDY IN ECONOMY"
ACTUAL MANUFACTURES
BY USING OUR

Foundry Blackings, Facings, Parting Powder, Core Gum, Terra Flake, Talc Coal Dusts, Ganister, Ceylon Plumbago (Imports direct). We definitely help to produce perfect Castings. Only the best minerals used in the making. A trial order will convince users of their economic value.

JOHN & C. DURRANS,
PENNINE WORKS, HAZLEHEAD,
NEAR SHEFFIELD.

Telephone: 128 Penistone. Telegrams: Facings, Penistone.

'Phone: 22877 SLOUGH

TWO NEW Core blowers for bombs.

TWO NEW Shotblasts for bombs or shells.

JOLT SQUEEZE "JACKMAN" MOULDING MACHINES, 14" x 16", as new. £90 each.

"NICHOLLS" Joltsqueeze 18" x 14". £90.

Morgan 250 lb. Tilting Furnace.

Monometer ½-ton Semi-rotary.

NEW PIT FURNACES 150 lbs. capacity, oil or coke fired. £35 each.

NEW SHOTBLAST CABINET PLANTS with motor driven Exhaust Fans, complete, all sizes. Prompt delivery.

PLAIN JOLT RAM, with table 54 ins. square, cyl. 12 ins. dia. £90.

ALEX. HAMMOND, *Foundry Machinery Merchants.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY.

WE SHOT OR SAND-BLAST FOR ALL TRADES

Airless and Pressure Blast Cleaning Plants

AIR COMPRESSORS
DUST ARRESTERS
CHILLED IRON SHOT—BLASTYTE
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